Skookumchuck Creek Juvenile Bull Trout and Habitat Fish Monitoring Program

Technical Manual
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BONNEVILLE POWER ADMINISTRATION

Skookumchuck Creek Juvenile Bull Trout and Fish Habitat Monitoring Program: 2002 Data Report

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BPA Project Number 2000-004-00,
Bonneville Power Administration, Fish and Wildlife Program
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Executive Summary

The Skookumchuck Creek juvenile bull trout (*Salvelinus confluentus*) and fish habitat-monitoring program is a co-operative initiative of the British Columbia Ministry of Water, Land, and Air Protection and Bonneville Power Administration. This project was commissioned in planning for fish habitat protection and forest development within the Skookumchuck Creek watershed and was intended to expand upon similar studies initiated within the Wigwam River from 2000 to 2002. The broad intent is to develop a better understanding of juvenile bull trout and Westslope cutthroat trout recruitment and the ongoing hydrologic and morphologic processes, especially as they relate to spawning and rearing habitat quality. The 2002 project year represents the first year of a long-term bull trout-monitoring program with current studies focused on collecting baseline information. This report provides a summary of results obtained to date.

Bull trout represented 72.4% of the catch. Fry dominated the catch because site selection was biased towards electrofishing sample sites which favored high bull trout fry capture success. The mean density of all juvenile bull trout was estimated to be 6.6 fish/100m^2. This represents one-half the densities reported for the 2002 Wigwam River enumeration program, even though enumeration of bull trout redds was an order of magnitude higher for the Wigwam River. Typically, areas with combined fry and juvenile densities greater than 1.5 fish per 100 m^2 are cited as critical rearing areas. Trends in abundance appeared to be related to proximity to spawning areas, bed material size, and water depth. Cover components utilized by juvenile and adult bull trout and cutthroat trout were interstices, boulder, depth, overhead vegetation and LWD.

The range of morphological stream types encompass the stable and resilient spectrum (C3(1), C3 and B3c). The Skookumchuck can be generalized as a slightly entrenched, meandering, riffle-pool, cobble dominated channel with a well-developed floodplain. The presence of an undisturbed riparian ecosystem dominated by mature, coniferous forest, combined with a high percentage of coarse particles in the stream bank, result in stable stream banks with low sediment supply. The results of the habitat assessment concur with the stable stream channel type and channel disturbance features noted were infrequent and minor in nature. Detailed summaries of channel profile, pattern, dimension and materials are provided in Appendices.

It was recommended that a fourth index site representing tributary spawning and rearing habitat be established in lower Sandown Creek and included for baseline data collection in year two.

Acknowledgements

The Skookumchuck Creek juvenile bull trout and fish habitat-monitoring program is a trans-boundary initiative implemented by the British Columbia Ministry of Water, Land, and Air Protection (MWLAP), in cooperation with Bonneville Power Administration (BPA). Funding was provided by BPA under the umbrella project "Monitor and Protect Bull Trout for Koocanusa Reservoir"; BPA project Number 2000-004-00. The contribution and on-going monitoring results provided by Herb Tepper and Bill Westover (MWLAP) are acknowledged and greatly appreciated.

Kerry Morris, and Jon Bisset of Westslope Fisheries contributed to data collection.

R. Lopaschuck (Nanrich Water Management Consultants) provided the 2002 Hydrometric Data from the Tembec Inc. Skookumchuck Creek water quantity and water quality inventory, 2002.

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1 Introduction

The Skookumchuck Creek juvenile bull trout (*Salvelinus confluentus*) and fish habitat monitoring program is a trans-boundary initiative implemented by the British Columbia Ministry of Water, Land, and Air Protection (MWLAP), in cooperation with Bonneville Power Administration (BPA). Skookumchuck Creek is a regionally significant sportfish stream located in southeastern British Columbia that supports healthy populations of both bull trout and Westslope cutthroat trout (Figure 1). Biotelemetry investigations have identified the upper Skookumchuck as an important bull trout-spawning stream in the Kootenay Region (B. Westover, MWLAP, Cranbrook, B.C., *pers. comm.*). Skookumchuck Creek also supports Westslope cutthroat trout (*Oncorhynchus clarki lewisi*) and these fish are highly sought after by anglers and commercial guides.

Bull trout populations have declined in many areas of their range within Montana and throughout the northwest including British Columbia. Bull trout were blue listed as vulnerable in British Columbia by the B.C. Conservation Data Center (Cannings 1993) and although there are many healthy populations of bull trout in the East Kootenay they remain a species of special concern. Bull trout in the United States portion of the Columbia River were listed as threatened in 1998 under the Endangered Species Act by the U.S. Fish and Wildlife Service. The upper Kootenay River is within the Kootenai sub-basin of the Mountain Columbia Province, one of the eleven Eco-provinces that make up the Columbia River Basin. MWLAP applied for and received funding from BPA to assess and monitor the status of wild, native stocks of bull trout in tributaries to Lake Koocanusa (Libby Reservoir) and the upper Kootenay River. This task is one of many that were undertaken to "Monitor and Protect Bull Trout for Koocanusa Reservoir" (BPA Project Number 2000-04-00).

1.1 Objectives

Three permanent sampling sites were established in the Skookumchuck Creek drainage in July 2002. All three sites were located on the mainstem Skookumchuck Creek. Site 1 was located in the lower river at Skookumchuck, outside the bounds of the “preferred” bull trout spawning and rearing reaches (Appendix A; 1:40,000 TRIM Map). Site 2 and 3 were located above the Skookumchuck canyon. Site 3 was located in the previously identified “preferred” bull trout spawning reach and site 2 was located immediately downstream this reach in an area of lower density bull trout spawning (Appendix A; 1:40,000 TRIM Map). At each site, juvenile fish densities, stream habitat conditions and detailed geomorphic surveys were measured. The objective of this project was to develop a better

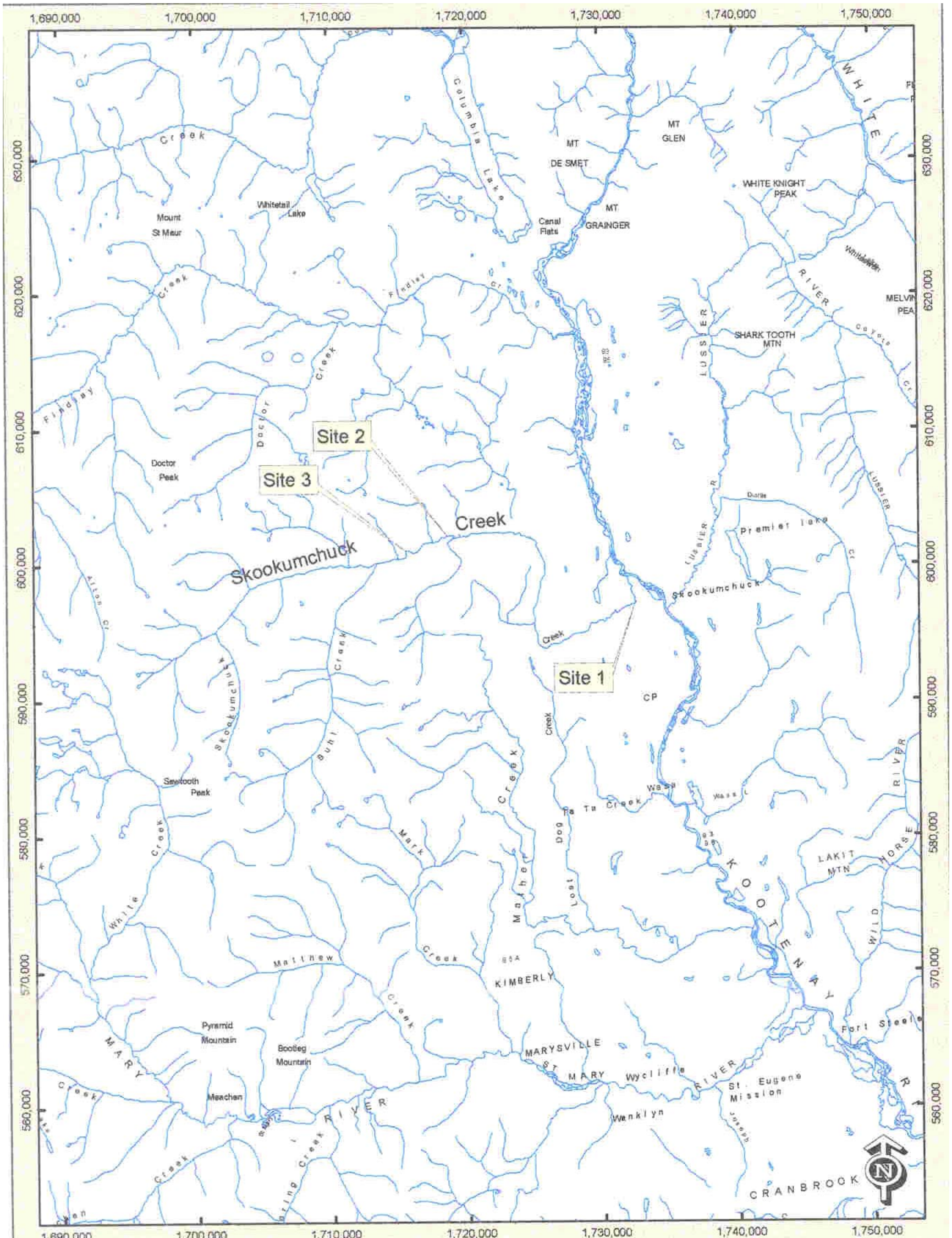

Figure 1 : Overview Map of the Skookumchuck Creek

Date: February 2003
Scale: 1 : 400 000
Drawing: Skookoverview.mxd
Projection: BC Albers - Nad 83 Datum

0 5 10 15 20
Kilometers

understanding of inter-annual variation in juvenile bull trout and Westslope cutthroat trout recruitment and the ongoing hydrologic and morphologic processes in Skookumchuck Creek, especially as they relate to spawning and rearing habitat quality.

1.2 Study Area

Skookumchuck Creek originates in the Purcell Mountains within the Purcell Wilderness Conservancy and flows east for 64 km until it empties into the Kootenay River, a tributary to Lake Koocanusa (Figure 1). The headwaters of the Skookumchuck drainage originate at an elevation of approximately 2,250 m and declines to 750 m. The Skookumchuck Creek valley is characterized by five biogeoclimatic zone variants; Kootenay dry mild ponderosa pine, Kootenay dry mild interior Douglas-fir, dry cool montane spruce, dry cool Engelmann spruce sub-alpine fir and alpine tundra (Braumandl and Curran 1992).

Skookumchuck Creek has a total watershed area of approximately 641 km^2. The flow regime of Skookumchuck Creek is comparable to most interior systems with high annual run-off reaching it's peak in June and expected low flows in late fall and winter (Figure 2). Freeze up generally occurs in mid to late November; however, areas of groundwater infiltration remain open in most years.

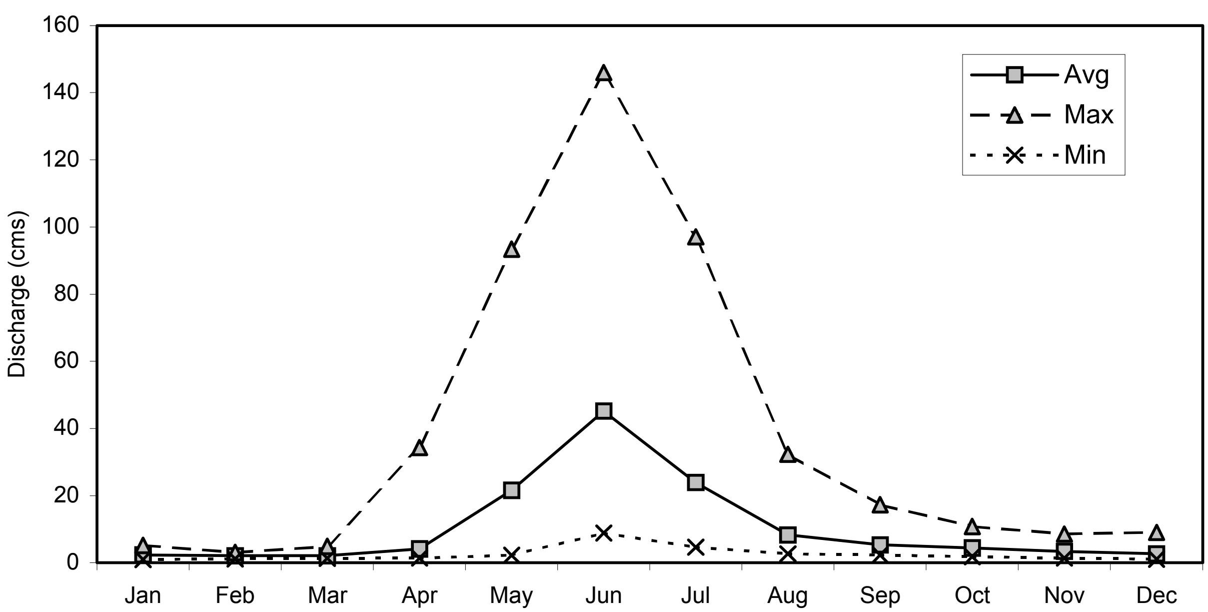

Figure 2. Mean, minimum, and maximum monthly discharge for Skookumchuck Creek near Skookumchuck, 1949 – 1955, 1963-1984 (WSC Stn No. 08NG051).

The upper reaches of Skookumchuck Creek occupy a narrow alluvial floodplain that is bounded by steep mountain slopes. Immediately below the Buhl Creek confluence an impassable falls limits upstream fish passage and represents the upstream limit to the study area (approximately river km 44). Immediately below the falls, Skookumchuck Creek occupies a narrow, alluvial floodplain associated with channel-confining bedrock outcrops. The combination of frequent lateral migration and erosion of adjacent terraces and coarse sediment delivery to the mainstem river has created a channel comprised of sorted cobbles, gravels and boulders that provide prime spawning and juvenile rearing habitat for bull trout. The occurrence of highly permeable glacial till within adjacent terraces has contributed to a predominance of sub-surface flow that reaches the mainstem as groundwater. The provision of suitably sized bed materials (<70 mm) in a low gradient, low water velocity location with associated groundwater have been identified as repeating patterns of preferred bull trout spawning habitat (McPhail and Baxter 1996). At approximately river kilometer 34 Skookumchuck Creek flows through a confined bedrock canyon that flows for approximately 31 kilometers before exiting into the Kootenay River valley, where it flows the final 3 kilometers to the Kootenay River.

1.1.1 Forest Harvesting

Forest harvesting and accompanying road development have a long history in the Skookumchuck Creek watershed. Canadian Pacific Railway (CPR) built and maintained a Skookumchuck camp (Echo Lake) from 1916 to 1930 and the Timberman directory for 1930 listed 180 men (Anon. 2002). The Westcoast Lumberman reported in 1935 that the Crowsnest Pass Lumber Company was building a sawmill at Skookumchuck, and that they expected to cut 15 million feet that season (Anon. 2002). Kootenay Ripples (Anon. 2002) references portable sawmills and camps “up the Skookumchuck” in the 1940’s and in 1956 L&Q Lumber Limited bought the logging and sawmill operations up the Skookumchuck River belonging to C. Wenger and family and the camp became “quite a little settlement”. To this day, old structures, sawdust piles, wood waste and camp debris still remain from this era of “bush” camps within the watershed. In September of 1968 the Tembec Inc. bleached kraft pulp mill started operation at Skookumchuck where it operates today.

Tembec Inc. is the current Forest licensee (F.L. A18978) in the Skookumchuck Creek watershed. The current five-year Forest Development Plan (FDP) was initiated in 2001. In the past year (Oct 01 to Sept 02) a total of 417.3 ha or 123,976 m^3 of harvest volume was logged within the Skookumchuck, Buhl and Sandown sub-basins. For the remaining four years of the FDP (2002-2006), there remains a total of 324.5 ha or 72,958.7 m^3 of harvest volume representing the final 37% of the scheduled harvest.

1.1.2 Fisheries Resource Status

Provincial management objectives for Skookumchuck Creek are protection of bull trout and Westslope cutthroat trout spawning areas and angler use of wild fish. Bull trout and Westslope cutthroat trout are the primary management species and are highly sought after by local, regional and international anglers. A local commercial guiding industry caters to recreational fishermen targeting these fish.

Bull trout populations have been shown to be extremely susceptible to habitat degradation and over harvest (McPhail and Baxter 1996, Ratliff *et al*. 1996) and are ecologically important as an indicator of watershed health (Baxter 1997). Bull trout are not found in streams where maximum monthly water temperatures exceed 18^{o}C and are most abundant where water temperatures are 12^{o}C or less (Goetz 1989, Ford *et. al.* 1995, McPhail and Baxter 1996, Buchanan and Gregory 1997). This preference for cooler water manifests in the frequent association of bull trout with cold perennial springs (Oliver 1979, Goetz 1989, McPhail and Baxter 1996, Buchanan and Gregory 1997).

When compared to other bull trout systems, the large spawning escapement of upper Kootenay River bull trout provide a strong case that this population may be the most prolific bull trout population in the species distributional range (Figure 3). Wigwam River juvenile bull trout fish and fish habitat studies have demonstrated that this population represents a large and stable population and are ecologically important as an indicator of watershed health. As such, it was concluded that the upper Wigwam River watershed remains relatively pristine, and maintains high water quality, high habitat capability and, conservative angling regulations have been successful in preventing over-exploitation (Cope 2003).

Westslope cutthroat trout are also typical of cold, nutrient poor streams (Liknes and Graham 1988). The Skookumchuck Creek population of Westslope cutthroat trout contains appreciable numbers of large individuals with adults attaining 450 mm fork length. Although the distribution and abundance of Westslope cutthroat trout have drastically declined from its historic range during the last 100 years, the abundance and size of the current Skookumchuck Creek population may be attributed to the combination of special regulations designed to limit harvest and high quality available habitat.

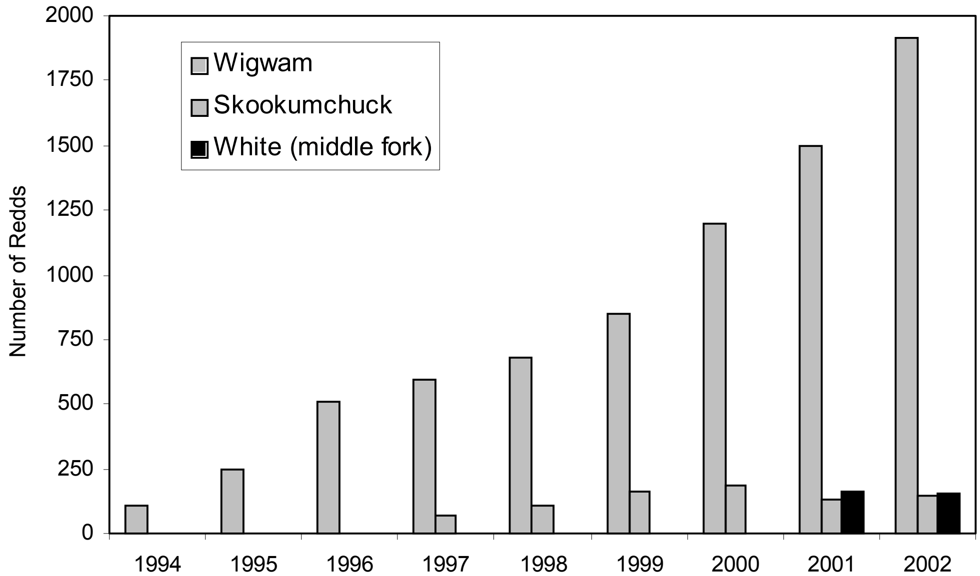

Figure 3. Summary of bull trout spawning surveys conducted on the three most important upper Kootenay River spawning tributaries identified using radio-telemetry.

Forest development plans for bull trout spawning and rearing tributaries have come under considerable scrutiny because of potential impacts to bull trout habitat. The issues have largely centered on block size, water temperature, increased sediment yield, and base flow levels in the mainstem river. The creation of extensive openings are intended to mimic a natural stand initiating event consistent with wildfire history. The size and extent of the proposed clear-cuts however, are perceived to alter basin hydrology, affect the annual flow regime (both peak and base flows) and encourage surface erosion that could lead to fine sediment delivery.

Historical stocking of non-indigenous species also represent a concern within Skookumchuck Creek. Brook trout readily hybridize with bull trout and although there are no stocking records for this species they have been identified (FISS 2002). In 1949 a cutthroat/rainbow trout hybrid was stocked in the Skookumchuck and Westslope cutthroat trout eyed eggs or fry were stocked in twelve years between 1942 and 1957(FISS 2002).

2 Methods

Three permanent sampling sites were established in the Skookumchuck Creek drainage in July 2002. The UTM coordinates for the upstream and downstream limits of the longitudinal survey, the pool and riffle cross-sectional survey habitat units and the electrofishing sample sites were overlain on the digital NAD 83 Forest Cover TRIM Sheet and plotted (Appendix A, 1:40,000 TRIM map).

Sampling sites were a minimum of 20 channel widths in length or a distance equal to two stream meander wavelengths. At each site the following reference points were permanently established, geo-referenced (UTM) and marked with a combination of metal tree tag, tree blaze, fluorescent tree paint, and flagging tape:

- Upstream and downstream elevation benchmarks. Elevation benchmarks were represented by a lag bolt imbedded in the base of a large, stable, riparian tree,
- Upstream and downstream limits of the longitudinal survey,
- Riffle and pool cross-sectional benchmarks (lag bolt imbedded in the base of a riparian tree) and bank “pins” representing the start and finish reference points, and
- Electrofishing habitat units.

The following methods outline the specific assessments completed at each of the three permanently established sites.

2.1 Juvenile Enumeration

Estimates of juvenile fish density (number of fish/100 m^2) were determined using closed, maximum-likelihood removal estimates (Riley and Fausch 1992). For each site, three habitat units (riffle, pool and run) were individually sampled for fish densities over a minimum of 100 lineal meters and/or 500 m^2. This methodology allows for habitat unit comparisons as well as reach comparisons through pooling of habitat units to obtain a mean. A Smith-Root Mark 12POW backpack electroshocker was used for successive depletions within each closed sample unit. Although bull trout are the main focus of this project, densities of all fish captured were reported.

Catch results from individual habitat units were summed, by pass, at each representative reach location. These results were then used to estimate the number of fry (0^+ age class) and juveniles (1^+ and 2^+ age classes) within the composite enclosure area. Population estimates were calculated using the "Microfish" software package (Van Deventer and Platts 1990). Population estimates and their 95% confidence interval were then reported as a standard numerical density (number fish/100 m^2) for each site.

During electrofishing surveys, stream discharge was estimated at each location using a Price 1210AA velocity meter and wading rod calibrated bi-annually by the National Calibration Service of the National Water research Institute. All methods meet national and provincial standards and have demonstrated precision levels of less than +/- 5% (Prince and Morris 2003).

2.2 Fish Habitat Assessment

A standard suite of habitat parameters were collected using the Resource Inventory Committee (RIC) approved Fish Habitat Assessment Procedures (FHAP), Level 1, Form 4 - Habitat Survey Data Form (Johnston and Slaney 1996). The level 1 FHAP is a purposive field survey of current habitat conditions for the target species in select reaches. This form has been developed for interpretation of habitat sensitivity and capability for fish production and includes prominent physical features such as pool and riffle ratios, residual pool depths, channel stability, flood indicators, cover components, abundance of large woody debris (LWD), and riparian vegetation.

Following methods described in Rosgen (1996) the following measurement of channel profile, pattern and dimension were also completed:

- A longitudinal profile (minimum of 20 channel widths in length or a distance equal to two stream meander wavelengths) of the stream bed following the thalweg of the stream channel including measurement of water surface (slope) and bankfull elevations;
- Stream cross-sections on both a riffle and pool segment (stream bed, water surface, thalweg and bankfull elevations);
- Channel pattern (width flood prone area, sinuosity, belt width, meander length and radius of curvature), and
- Modified Wolman pebble count (reach and active channel at a riffle).

At 10m intervals, following the thalweg of the stream channel, the elevation of the streambed and the water surface was surveyed over the length of the study area. All stream and habitat unit gradients were calculated from differences in water surface elevation. Cross sectional profiles were surveyed at 1 m intervals and extended 5m beyond the bankfull width. The elevation of the bankfull channel was also noted at each cross section location and periodically throughout the longitudinal survey. Geomorphic surveys were completed using an auto level (Topcon AT-G7 Auto Level) and standard differential hydrometric survey techniques (Anon. 1998). A differential loop was used to accurately determine benchmark elevations, express error terms and ensure quality control.

Channel bed material characterization employed the modified Wolman method outlined in Rosgen (1996). Briefly, this procedure uses a stratified, systematic sampling method based on the frequency of riffle/pools and step/pools occurring within a channel reach that is approximately 20-30 bankfull channel widths in length (or two meander wavelengths). The modified method adjusts the material sampling locations so that various bed features are sampled on a proportional basis along a given stream reach. In total, 10 transects are established and ten substrate particles are selected at systematic intervals across the bankfull channel width, for a total sample size of 100. To avoid potential bias, the actual particle was selected on the first blind touch, rather than visually selected. The intermediate axis of the particle was measured such that the particle size selected would be retained or pass a standard sieve of fixed opening. The composite particle distribution was used to represent the reach. A second modified Wolman pebble count was completed within the active channel (*i.e*. within the wetted width), at the representative riffle cross-section, to calculate D_{84}. The D_{84} estimate was then used as a roughness coefficient in velocity calculations (Appendix G).

3 Results

The sampling schedule for the 2002 fish and fish habitat-monitoring program is summarized in Table 1.

Table 1. Schedule of program field components for the Skookumchuck Creek bull trout and fish habitat monitoring program, 2002.

Program Component	Date
Establishment of Permanent Sample Sites	July 24
Juvenile Fish Density Sampling	August 12-15
Level 1 FHAP Form 4 Measurements and Channel Surveys	September 22 – October 1

3.1 Juvenile Fish Sampling

3.1.1 Species Composition and Distribution

In total, 9 habitat units were sampled across three sites (Appendix B). Table 2 summarizes sample effort and total catch across sites.

Table 2. Total effort (seconds of backpack electrofishing and area) and catch (no. of fry and juvenile bull trout and Westlsope cutthroat trout combined) for the three Skookumchuck Creek bull trout index sites. Note that the non-salmonid catch from the lower Skookumchuck Creek site has been included in the totals denoted by brackets.

Site	Electrofishing Effort (seconds)	Sample Area (m^2)	Total Catch (No. Fish)
1	3,425	502	4(34)
2	3,135	452	43
3	3,155	465	39
Total	9,715	1419	86(116)

In total, 116 fish were captured within the Skookumchuck Creek index sites (Table 3). A total of 86 juvenile bull trout (BT) and Westslope cutthroat trout (WCT) representing 74.1% of the catch were captured during the sample period 12 – 15 August 2002. Bull trout were the dominant salmonid species encountered, representing 72.4% (n = 84) of the total catch. Westslope cutthroat trout (n = 2) represented 1.7% of the total catch. Bull trout fry were the target species and life stage and as such, their predominance in the catch composition reflects bias associated with site selection for this capture target. Additional non-salmonid catch was represented by longnose suckers (LSU) and torrent sculpins (CRH) that were captured exclusively within the lower watershed index site (Table 3).

Table 3. Catch composition for the Skookumchuck Creek juvenile bull trout monitoring program.

Site	BT Fry	BT Juv.	WCT Fry	Wct Juv.	LSU	CRH	Total
1	4				15	15	4(34)
2	37	5		1			43
3	38		1				39
Totals	79	5	1	1	15	15	86(116)

3.1.2 Bull Trout

Bull trout fry (n=79) were captured in all sample sites and bull trout juveniles (n=5) were captured exclusively in Site 2. In total, 84 bull trout were captured and sampled for life history information (Table 4). All captured bull trout were fry or juveniles and ranged in fork length from 36 mm to 95 mm and the modal class, in 10 mm intervals, was 41-50 mm (Figure 4). This size class represents the young-of-the-year cohort (fry, 0^+). The relative proportions of age classes comprising the total bull trout catch were 94% fry (0^+) and 6% juveniles (1^+). Mean fork lengths of each age class (estimate) were 44.6 (0^+) and 88.4 (1^+) mm. The corresponding mean weights for bull trout age classes were 0.85 and 7.4 g respectively (Table 4). The growth rate of juvenile bull trout in the Skookumchuck Creek study area was described by the equation:

$Log_{10}Weight = -5.31 + 3.17\ Log_{10}Length$ (Figure 5).

Table 4. Summary of fork length and weight data collected from bull trout captured within the Skookumchuck Creek drainage, August 2002.

	Age-Group	
	0^{+}	1^{+}
Mean Fork Length (mm)	44.6	88.4
Standard Error	0.36	2.60
Range	36 – 52	79 – 95
N	79	5
Mean Weight (g)	0.85	7.4
Standard Error	0.02	0.61
Range	0.3 – 1.3	5.4 – 9.2
N	79	5

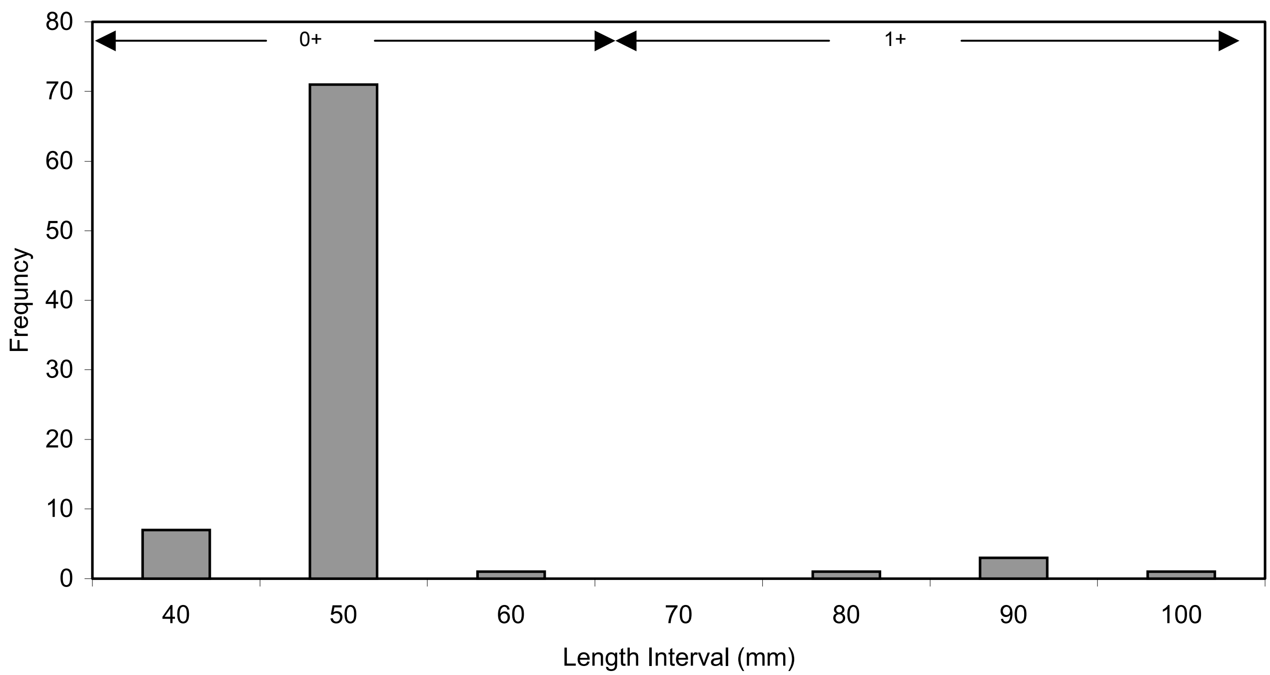

Figure 4. Length frequency distribution and estimated age cohorts for Skookumchuck Creek juvenile bull trout, August 2002.

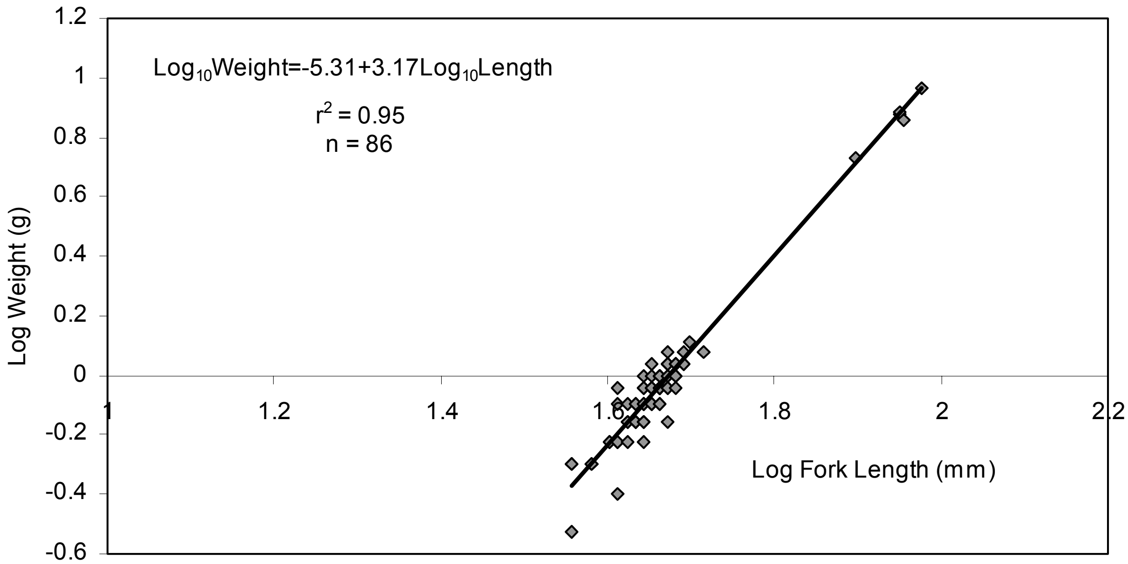

Figure 5. Length-weight regression for bull trout captured within the Skookumchuck Creek watershed, August 2002.

The overall mean density of juvenile bull trout (ages 0^+ and 1^+ combined) was estimated to be 6.6 fish/100 m^2 (95% confidence interval 5.9 – 7.3 fish/100 m^2). The mean density of juvenile bull trout within individual index sites ranged from 0.8 to 9.7 fish/100 m^2 (Table 5). Densities were significantly lower in the lower Skookumchuck than the upper Skookumchuck. Trends in fry abundance are related to proximity to spawning areas and the observed distribution was expected in 2002 juvenile density sampling.

Table 5. Mean density estimates (+/- 95% confidence interval) for juvenile bull trout (ages 0^+ and 1^+ combined) at three permanent sample sites, within the Skookumchuck Creek watershed.

Site	Density (+/- 95% C.I.) fish/100 m^2
Skookumchuck Creek – Site 1	0.8 (0.8 – 1.7)
Skookumchuck Creek – Site 2	9.7 (9.3 – 10.9)
Skookumchuck Creek –Site 3	8.8 (8.2 – 10.3)

3.1.3 Westslope Cutthroat Trout

In total, 2 Westslope cutthroat trout (fork lengths 55 and 211 mm) were captured at site 3 and 2, respectively. Westslope cutthroat trout were not the target species and captures (n=2) were not sufficient to generate site-specific density estimates and the small sample size precludes analyses.

3.2 Physical Habitat Monitoring

3.2.1 Water Temperature and Discharge

Discharge estimates within the Skookumchuck Creek index sites, during habitat sampling, ranged from 5.05 to 7.52 m^3/s (Table 6). The 2002 (20 April to 29 October) minimum and maximum mean daily discharge at the lower (Km 2) and upper (km 45) Skookumchuck Creek hydrometric stations ranged from 2.85 to 105 m^3/s and from 1.02 to 53.2 m^3/s, respectively (Figure 6). Maximum mean daily discharge (June 17, 2002) for the lower and upper Skookumchuck was 125 and 74.2 m^3/s.

Bankfull discharge was estimated from flood frequency analysis conducted using maximum daily mean discharges (maximum instantaneous values were not available) recorded at both the historical Water Survey of Canada Hydrometric Station 08NG051 and the existing hydrometric station located near the Skookumchuck Pulp Mill at km 2 (Figure 7; 1949-55; 1963-84; 2002-2002 n=29). Estimated bankfull discharge at the gauging station was 68.2 m^3/s based on a return frequency of 1.5 years. Table 7 shows the estimated bankfull discharge at the three index site stream gauging locations. The estimated bankfull discharge at Site 1 (79.1 m^3/s) corresponds closely to a return frequency of 5 years at the gauging station. The bankfull discharge estimates for the study area above the WSC gauge were calculated using the slope-area method for peak discharge determination:

Estimated Bankfull Discharge (Q_{bkf}) = $(1/n\ A_{bkf}\ R_{bkf}^{\ 2/3}\ S^{\ 1/2})$

Table 6. Summary of water temperature, mean velocity, and discharge measurements for the Skookumchuck Creek monitoring sites August 2002. Note that discharge is calculated based on the mid-section method (Anon 1998).

Site	Date	Water Temp. (°C)	Mean Velocity (m/s)	Cross Sectional Area (m^2)	Discharge (m^3/s)
Skookumchuck Creek Site 1	12 August	11.3	0.59	11.09	7.52
Skookumchuck Creek Site 2	14 August	11.8	0.40	13.40	5.73
Skookumchuck Creek Site 3	15 August	10.9	0.39	11.88	5.05

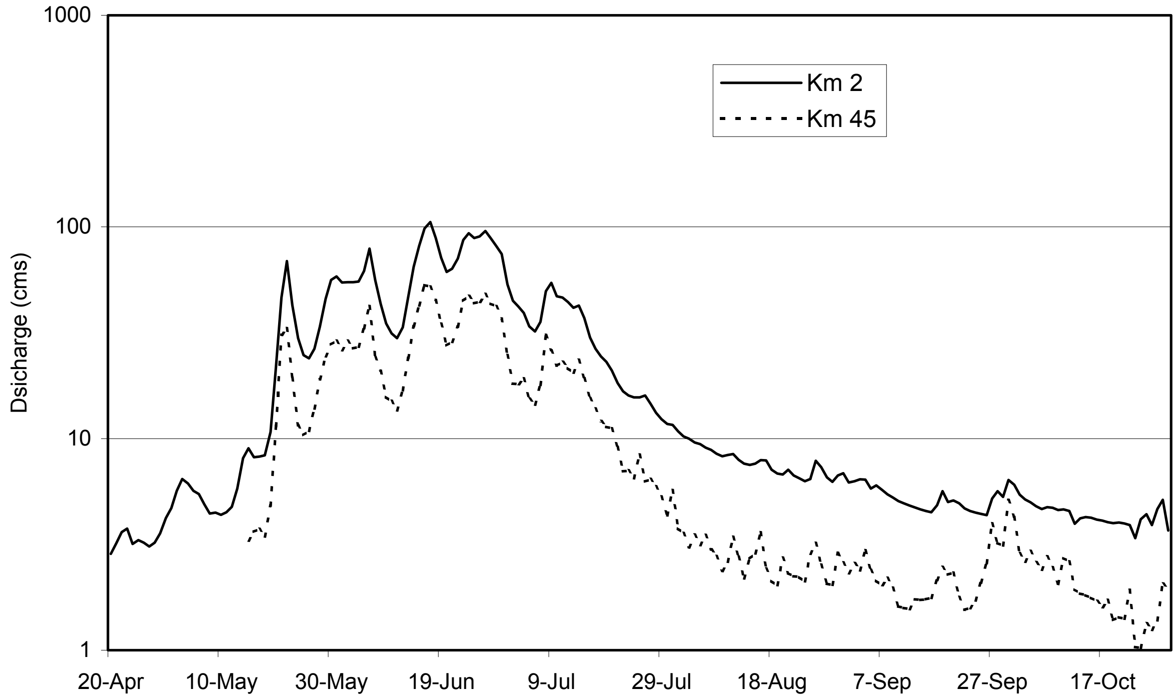

Figure 6. Mean daily discharge for the upper and lower Skookumchuck Creek hydrometric stations at approximate river kilometers 2 and 45 (R. Lopaschuck, File Data).

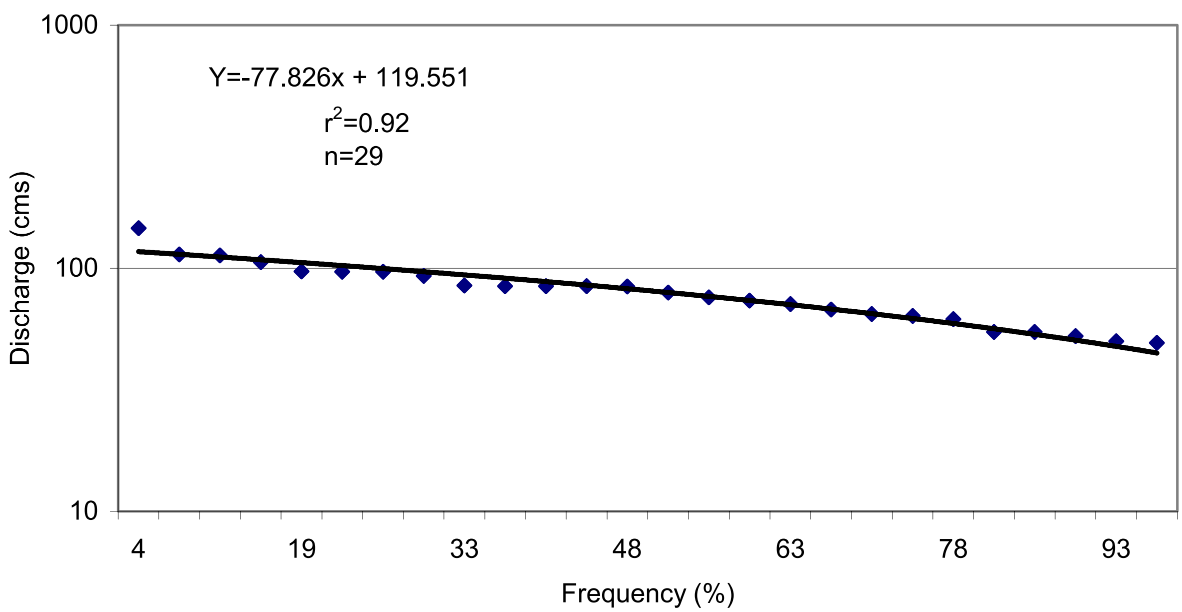

Figure 7. Flood-frequency analysis using maximum daily discharge for Skookumchuck Creek Water Survey of Canada Station 08NG051 (1949-55; 1963-84; 2000-02).

Table 7. Bankfull discharge estimates for the three index study sites based on the "slope-area method for determination of peak discharge" using measurements at field index site stream gauging locations, August 2002.

Site Number	n	A (m2)	R (m)	S	v	Q
Site 1 (km 2.0)	0.036	40.85	1.26	0.00645	1.94	79.1
Site 2 (km 40.5)	0.042	42.71	1.30	0.00530	1.52	64.8
Site 3 (km 42.0)	0.041	37.58	1.27	0.00382	0.94	35.4

Spot temperatures during electrofishing were well within bull trout tolerance limits (<18 ^{o}C) and in general, were indicative of cold perennial springs preferred by bull trout (<12 ^{o}C). Peak daily water temperatures (August 12-15) for the Skookumchuck Creek were approximately 13.6 at Site 1 (lower river) and 11.8 and 10.9 ^{o}C at Site 2 and 3, respectively.

3.1.2 Substrate Pebble Counts

Mean size of sediment particles less than six percent categories (*i.e.* D_{16}, D_{35}, D_{50}, D_{65}, D_{84}, D_{95}) are provided for the 2002 pebble counts. Both the active channel in a riffle and the reach composite within the bankfull channel are presented for the three index sites (Table 8). The preferred spawning reach (Site 3) was dominated by small to large cobbles with gravel substrate sub-dominant (Appendix D).

Table 8. Summary of substrate pebble counts for the Skookumchuck Creek fish habitat monitoring sites, 2002.

Site	D^{16}(mm)	D^{35}(mm)	D^{50}(mm)	D^{65}(mm)	D^{84}(mm)	D^{95}(mm)
Skookumchuck Creek Site 1 (Reach)	16.9	65.2	98.5	169	249	352
Skookumchuck Creek Site 1 (Active Channel)	84.1	115.0	141.6	171	221	256
Skookumchuck Creek Site 2 (Reach)	11.0	42.0	90.0	136	231	332
Skookumchuck Creek Site 2 (Active Channel)	96.6	133.8	167.1	202	253	362
Skookumchuck Creek Site 3 (Reach)	7.8	40.8	79.6	115	190	286
Skookumchuck Creek Site 3 (Active Channel)	83.7	119.3	151.8	191	252	512

3.1.3 Channel Surveys

Channel longitudinal and cross sectional profiles were completed for each of the sample stations and were presented in Appendix D. Detailed quantitative summaries are presented in the Stream Classification Form (Appendix E), the Reference Reach Data Summary Form (Appendix F) and the Velocity Calculation Form (Appendix G). The following summarizes the general channel features noted with associated representative riffle and pool photographs.

Skookumchuck Creek Site 1

Site 1 was classified as a C3(1) Rosgen stream type (Figures 8 and 9). The (1) designation refers to the presence of bedrock outcrops that were associated with pools. This site was adjacent to the Skookumchuck Pulp mill and riparian development, eroding banks and channel alterations were noted. The channel slope was 0.65% and bankfull width was 34.3 m within a flood-prone width of 164 m. This site was representative of the lower Skookumchuck Creek watershed where it exits the Skookumchuck Canyon and flows through the Kootenay River terrace. Site 1 represented the lower Skookumchuck outside the “preferred” bull trout spawning reaches and had a higher gradient with lower pool frequency, lower LWD frequency and a smaller gravel fraction within the streambed.

Figure 8. Representative riffle habitat, Site 1, Skookumchuck Creek, 2002.

Figure 9. Representative pool habitat, Site 1, Skookumchuck Creek, 2002.

Skookumchuck Creek Site 2

Site 2 was classified as a C3 Rosgen stream type (Figures 10 and 11). This site was noted for its frequent deep pools, off-channel habitat, groundwater infiltration, and stable stream banks. The channel slope was 0.35% and bankfull width was 41.2 m within a flood-prone width of 116 m. It should be noted that some of the field measurements may have been taken at locations unrepresentative of the site. The values generated from the field measurements bias further calculations and ratio values. Specifically, the chosen riffle habitat unit might be much wider than all other riffle habitat units in the rest of the index site. The field measurements in question, along with the location of the riffle cross section will be re-evaluated next field season.

This site was representative of low-density bull trout spawning habitat within the upper Skookumchuck. Site 2 was noted for its habitat heterogeneity and of the three index sites, had the highest channel sinuosity, lowest gradient, highest pool frequency and LWD frequency and highest sub-dominant fraction of gravels within the streambed (Appendix D). LWD frequency was most likely under-represented due to the clumped distribution of LWD and the low sample frequency (*i.e*. two meander lengths).

Figure 10. Representative riffle habitat, Site 2, Skookumchuck Creek, 2002.

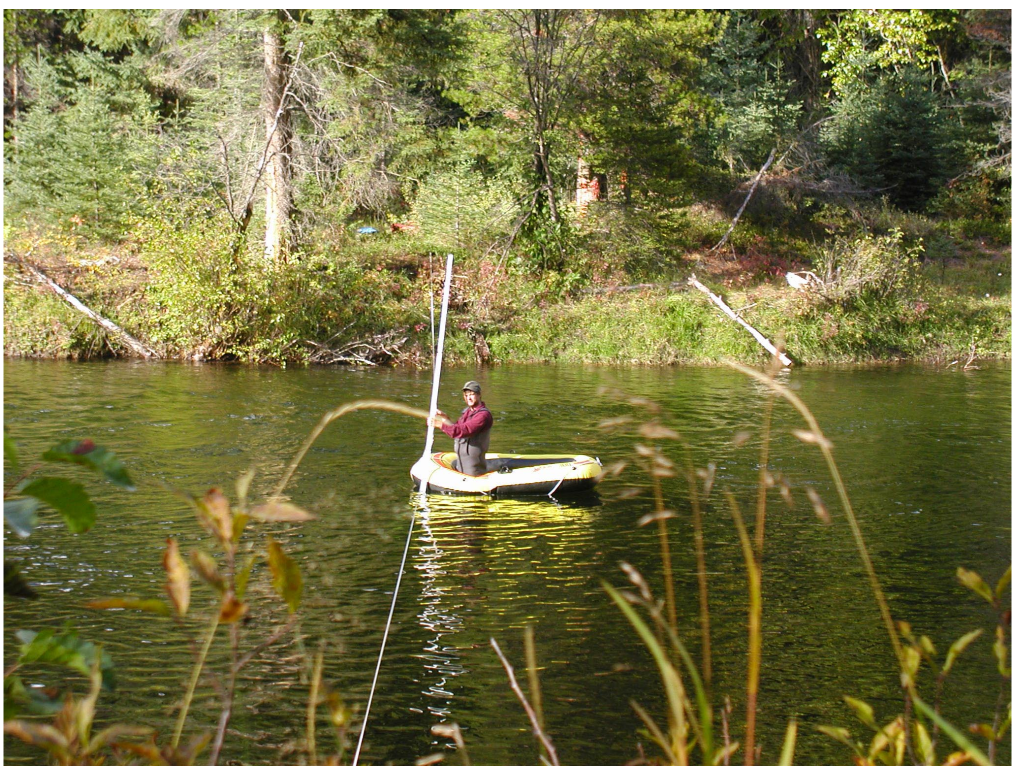

Figure 11. Representative pool habitat, Site 2, Skookumchuck Creek, 2002.

Skookumchuck Creek Site 3

This site was representative of the preferred bull trout spawning habitat immediately below the falls at km 45. Of the three index sites, site 3 was noted as being intermediate in its habitat heterogeneity. Channel sinuosity, gradient and pool frequency were similar to site 2 but slightly reduced, while entrenchment ratio was the lowest of the three sites. gravel substrate This site was noted for its frequent pools, higher proportion of spawning substrate, groundwater infiltration, and stable stream banks. The channel slope was 0.38% and bankfull width was 32.8 m within a flood-prone width of 67 m.

Site 3 was classified as a B3c Rosgen stream type (Figures 12 and 13). The c designation refers to the low gradient “C” channel characteristics of this sub-variant B channel. The B3c classification appears to be the result of entrenchment increasing to just beyond the C3 range. The two meander lengths selected for survey are transitional between the B3 and C3 channel types as the reach approaches the falls 2.5 kilometers upstream. Replication of the riffle cross-section in the downstream meander would most likely result in a C3 stream classification.

Figure 12. Representative riffle habitat, Site 3, Skookumchuck Creek, 2002.

Figure 13. Representative pool habitat, Site 3, Skookumchuck Creek, 2002.

3.2.3 Fish Habitat Survey (FHAP Form 4)

The Level 1 Fish Habitat Assessment Procedure (FHAP) is a purposive field survey of current habitat conditions for the target species in select reaches. In this study, the Level 1 FHAP Form 4 was completed for the representative sample sites (two meander wavelengths) within the selected reaches. The output of the WRP data reporting tool are presented in Appendix C and have been archived for long-term trend monitoring. Generic diagnostic data have been summarized as descriptors of present habitat condition (Table 9). Cover components utilized by juvenile and adult bull trout and cutthroat trout were interstices, boulder, depth and overhead vegetation. LWD distribution was clumped and was under-represented by low sampling frequency (*i.e.* 2 meander lengths).

Note that regional criteria for habitat conditions do not exist and current WRP diagnostic criteria to evaluate habitat condition are exclusive of bull trout and Westslope cutthroat trout data. Notwithstanding these limitations, diagnostic data clearly indicate the high quality spawning and rearing habitat ratings for sites 2 and 3. Bankfull channel widths were derived from the riffle habitat unit cross-sectional survey data. Gradient was derived from the water surface elevation of the longitudinal profile.

Table 9. Diagnostics of salmonid habitat condition at the reach level for Skookumchuck Creek, 2002 (from Johnston and Slaney 1996). Note that the individual cell format represents value/rating[A, B].

	Habitat Parameter											
	Pool % (by area)	Pool Frequency (mean spacing)	LWD Pieces per Bankfull Channel Width	% Wood Cover in Pools	% Boulder Cover in Riffles	% Over-head Cover	Substrate Rearing Habitat (interstitial rating)	Off-Channel Habitat (< 3% gradient)	Holding Pools (> 1 m deep, good cover)	Spawning Gravel Quantity	Spawning Gravel Quality	Redd Scour Potential
Site 1 Skookumchuck Creek	18/P	7.2/P	1.4/F	0/P	7/P	<2/P	Clear/G	Few/P	Few/P	Limited/P	Suitable/G	High/P
Site 2 Skookumchuck Creek	52/F	1.5/G	0.9/P	<2/P	11/F	<2/P	Clear/G	Abundant/G	Abundant/G	Frequent/G	Suitable/G	Stable/G
Site 3 Skookumchuck Creek.	38/P	3.0/F	1.6/F	<2/P	<2/P	10/F	Clear/G	Some/F	Abundant/G	Frequent/G	Suitable/G	Stable/G

A Note: regional standards are not available and diagnostic ratings (G – good, F – fair, P – poor) are generalized ratings from Johnston and Slaney (1996) for streams with a bankfull channel width of less than 15 m.

B Note: two representative meander lengths were surveyed, not the entire reach.

4 Discussion

The 2002 project year represents the first year of a long-term bull trout-monitoring program with current studies focused on collecting baseline information within Skookumchuck Creek. The Skookumchuck Creek watershed has a long history of forest harvesting. The current 5-year Forest Development Plan will result in 196,934.7 m^3 of harvest volume or 741.8 ha representing 1.16% of the watershed area. Sandown Creek is an important Westslope cutthroat trout and possibly bull trout rearing and spawning stream in the upper Skookumchuck. Scheduled harvesting within this tributary watershed total 324.9 ha or 43.8% of the allowable harvest area for the current 5-year FDP. A fourth index site representing tributary spawning and rearing habitat should be established in lower Sandown Creek and included for baseline data collection in year two.

Relative to co-existing species, bull trout densities usually are low, and most broad faunal surveys indicate less than 5% of the total catch is made up of bull trout (McPhail and Baxter 1996, Reiman and McIntyre 1995). However, in the Skookumchuck Creek, bull trout represented 72.4% of the catch. Fry dominated the catch because site selection was biased towards electrofishing sample sites which favored high bull trout fry capture success.

The mean density of all juvenile bull trout was estimated to be 6.6 fish/100m^2. This represents one-half the densities reported for the 2002 Wigwam River enumeration program, even though enumeration of bull trout redds was an order of magnitude higher for the Wigwam River. Typically, areas with combined fry and juvenile densities greater than 1.5 fish per 100 m^2 are cited as critical rearing areas (Goetz 1989).

Maximum summer water temperatures of 14 – 18°C appear to limit bull trout distribution (Baxter and McPhail 1996) and the high water quality of the Skookumchuck Creek was reflected in the low maximum summer water temperatures (spot samples taken at 16:00) and ubiquitous juvenile bull trout distribution. Mean weekly maximum water temperatures (*i.e.* provincial guideline of 15°C for streams with bull trout) should be reviewed from the EMS database in year two to confirm conclusions drawn from the spot water temperatures.

Trends in abundance appeared to be related to proximity to spawning areas, bed material size, and water depth. The association of bull trout fry with shallow (5 – 20 cm), low velocity (<0.3 m/s), cobble dominated stream margin habitat has been previously documented within the Wigwam River (Cope 2003). Cobbles and gravels that provide prime spawning and juvenile rearing habitat dominate the upper Skookumchuck Creek. Cover components utilized by juvenile and adult bull trout and cutthroat trout were interstices, boulder, depth and overhead vegetation. LWD distribution was clumped and was under-represented by low sampling frequency (*i.e.* 2 meander lengths).

The range of morphological stream types encompasses the stable and resilient spectrum (C3(1), C3 and B3c). The Skookumchuck can be generalized as a slightly entrenched, meandering, riffle-pool, cobble dominated channel with a well developed floodplain. The presence of an undisturbed, riparian ecosystem dominated by mature, coniferous forest, combined with a high percentage of coarse particles in the stream bank result in stable stream banks with low sediment supply. The results of the habitat assessment concur with the stable stream channel type and channel disturbance features noted were infrequent and minor in nature.

The B3c classification appears to be the result of entrenchment increasing to just beyond the C3 range. The two meander lengths selected for survey are transitional between the B3 and C3 channel types as the reach approaches the falls 2.5 kilometers upstream. Replication of the riffle cross-section in the downstream meander would most likely result in a C3 stream classification. Width to depth ratios appear to be high in Site 2 and this was attributed to site-specific anomalies related to the placement of the riffle cross-section with no replication.

The upper Skookumchuck can be characterized by habitat heterogeneity. These reaches, with their high sinuosity, frequent deep pools, and high quality spawning and rearing habitat contains some of the prime bull trout and Westslope cutthroat trout spawning grounds found in the upper Kootenay River watershed and should be considered very sensitive. When compared to other bull trout systems, the spawning escapement and juvenile densities provide a strong case that the Skookumchuck Creek bull trout represent a significant and stable population with high juvenile bull trout survival rates. Bull trout populations have been shown to be extremely susceptible to habitat degradation and over harvest (McPhail and Baxter 1996, Ratliff *et al*. 1996) and are ecologically important as an indicator of watershed health (Baxter 1997). As such, the upper Skookumchuck Creek watershed remains relatively pristine, and maintains high water quality and high habitat capability. After eighty years of forest development and public access within the Skookumchuck Creek watershed, conservative forest harvesting levels that preserved the riparian ecosystem and angling regulations designed to limit harvest have been successful in preventing habitat degradation or over-exploitation of the fishery.

5 Recommendations

A fourth index site should be established in lower Sandown Creek to collect baseline information within this important tributary spawning and rearing habitat that also supports a major proportion of the current forest harvesting activity.

Maximum daily discharge from the Skookumchuck Water Quantity and Water Quality Inventory Project should be accessed through the EMS database and used to update the flood-frequency analysis in Year 2.

Mean weekly maximum water temperatures (i.e. provincial guideline of 15^{o}C for streams with bull trout) should be reviewed from the EMS database in year two to confirm the spot water temperatures collected in 2002.

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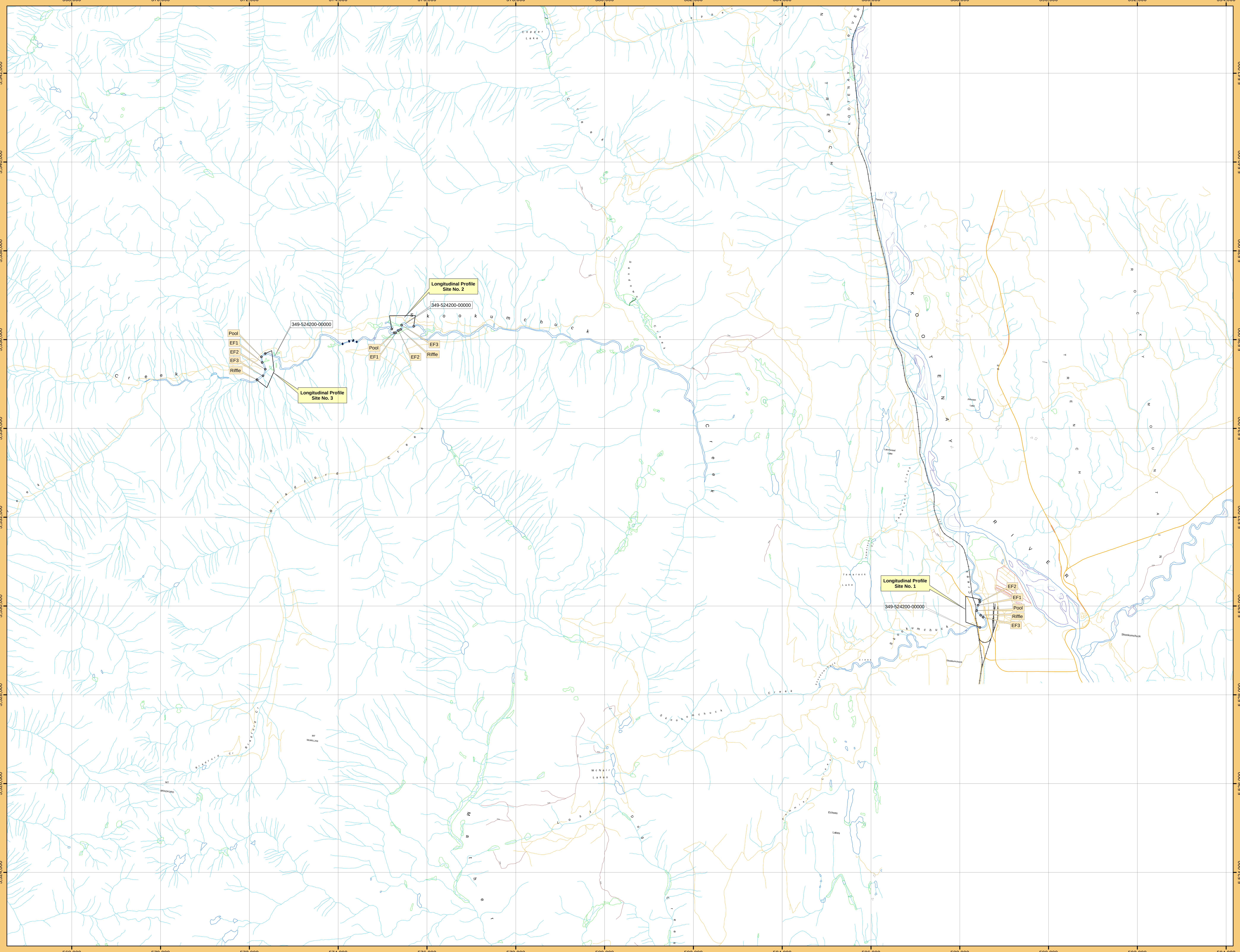
Appendix A

1:50,000 TRIM Map



Ministry of Water, Land and Air Protection

Skookumchuck Creek Juvenile Bull Trout and Fish Habitat Monitoring Program (2002)

Surveyed by:

Westslope Fisheries
517 13th Street South
Cranbrook, B.C. V1C 2W5
Tel: (250) 426-8381 Fax: (250) 426-8105

1,000 500 0 1,000 2,000 3,000 Meters

TRIM II Data - UTM Zone II Nad 83

Fish and Fish Habitat Assessment Summary

349-5242 — Watershed Code or Locational Point

Fish Species Information

BT KO MW (RB) — Species Present; () Species Suspected

Site No: 1 — Longitudinal Survey Boundary

KO* MW* MW* — Major Spawning

EF1 — Fish Electrofishing Site

Riffle — Habitat Cross-Section Survey

FSZ — Fisheries Sensitive Zone

Stream Survey Site

2 — Biophysical Stream Reach Boundary

Obstructions

(Measurements Included Where Known)

X — Log Jam (Persistent)

F —
BD = Beaver Dam
C = Cascade/Chute
CV = Culvert
F = Falls
G = Gradient Barrier
LS = Landslide
RS = Rockslide
U = Unknown

C100 —
C = Cascade, Chute
(Length:100m)
DCHAN = Destabilized Channel

Fish Species Abbreviation List and Instream Operating Windows

Code	Species Name	Spawning Season	Instream Operating Windows
BB	Burbot	February	August
BT	Bull Trout	September	August
EB	Eastern Brook Trout	September	August
KO	Kokanee	Sept - Oct	August
MW	Mountain Whitefish	November	August
OS	Non-Game Species		
RB	Rainbow Trout	April - May	August
WCT	Westslope Cutthroat	May - June	August

River/Stream - Definite
River/Stream - Indefinite
River/Stream - Left Bank
River/Stream - Right Bank
Lake - Definite
Lake - Indefinite
Reservoir - Definite
Swamp / Marsh
Gravel Road
Paved Road
Embankment/Fill
Trail
Rail Line

Mapping by:

PURCELL RESOURCES INC.
1100 11th Street S. - Cranbrook, B.C. - V1C 1V8
Tel: (250) 417-0662 - Fax: (250) 417-0688
purcell.res@shawcable.com

Date: February 2003
Scale: 1 : 40 000
Ref Maps: 082g.091, 092
Drawing: Skook.mxd
Project No: 0219
Projection: UTM Zone II - Nad 83 Datum

Appendix B

Fish Capture Data

FDIS Fish Card

		Reach #	ILP Map #	ILP #
Watershed Code:	349-524200-00000-00000-0000-0000-000-000-000-000-000-000	1.0		

WATERBODY

Gazetted Name: SKOOKUMCHUCK CREEK Local: Pulp Mill Site
Project Code: 349-524200-00000-00000-0000-0000-000-000-000-000-000-
WS Code: 349-524200-00000-00000-0000-0000-000-000-000-000-000-000
Waterbody ID: ILP Map #: ILP #: Reach #: 1 -
Project ID: 5862 Lake/Stream: S Lake From Date:

Fish Permit #: 02-04-0860 Date: 2002/08/12 To: 2002/08/12 Agency: C214 Crew: SC/JB/KM Resample: ☐

SITE / METHOD

Site#	NID Map	NID #	UTM:Zone/East/North/Mthd				MTD/NO		Temp	Cond	Turbid	Comment
3		3	11	588414	5529766	GP3	EF	1	13.6	79	C	Riffle
2		2	11	588451	5530088	GP3	EF	1	13.2	65	C	Glide
1		1	11	588484	5530017	GP3	EF	1	11.3	61	C	Pool

A. GEAR SETTINGS

Site#	MTD/NO		H/P	Date In	Time In	Date Out	Time Out	Comment
1	EF	1	1	2002/08/12	10:00	2002/08/12	10:25	
1	EF	1	2	2002/08/12	10:30	2002/08/12	11:00	
1	EF	1	3	2002/08/12	11:05	2002/08/12	11:40	
2	EF	1	1	2002/08/12	12:45	2002/08/12	13:20	
2	EF	1	2	2002/08/12	13:25	2002/08/12	13:45	
2	EF	1	3	2002/08/12	13:47	2002/08/12	14:10	
3	EF	1	1	2002/08/12	15:35	2002/08/12	16:10	
3	EF	1	2	2002/08/12	16:15	2002/08/12	16:41	
3	EF	1	3	2002/08/12	16:44	2002/08/12	17:01	

C. ELECTROFISHER SPECIFICATIONS

Site#	MTD/NO		H/P	Encl	Sec	Length	Width	Voltage	Frequency	Pulse	Make	Model
1	EF	1	1	C	1072	16.0	10.0	300	60	6	SR	12A
1	EF	1	2	C	1138	16.0	10.0	300	60	6	SR	12A
1	EF	1	3	C	1150	16.0	10.0	300	60	6	SR	12A
2	EF	1	1	C	1075	26.3	7.3	300	60	6	SR	12A
2	EF	1	2	C	813	26.3	7.3	300	60	6	SR	12A
2	EF	1	3	C	726	36.3	7.3	300	60	6	SR	12A
3	EF	1	1	C	1278	25.0	6.0	300	60	6	SR	12A
3	EF	1	2	C	885	25.0	6.0	300	60	6	SR	12A
3	EF	1	3	C	798	25.0	6.0	300	60	6	SR	12A

FISH SUMMARY

Site#	MTD/NO		H/P	Species	Stage	Age	Total #	Lgth (Min/Max)		FishAct	Comment
1	EF	1	1	CRH	J		1	40	40	R	
1	EF	1	1	BT	F	0+	1	45	45	R	
1	EF	1	2	CRH	J		1	47	47	R	
1	EF	1	2	BT	F	0+	2	36	41	R	
1	EF	1	3	BT	F	0+	1	45	45	R	
2	EF	1	1	LSU	J		6	61	116	R	
2	EF	1	2	LSU	J		2	99	111	R	
2	EF	1	3	CRH	J		1	71	71	R	
2	EF	1	3	LSU	J		5	74	119	R	
3	EF	1	1	LSU	J		2	78	80	R	
3	EF	1	1	CRH	J		5	41	50	R	
3	EF	1	2	CRH	J		5	42	52	R	
3	EF	1	3	CRH	J		2	49	53	R	

INDIVIDUAL FISH DATA

Site#	MTD/NO		H/P	Species	Length	Weight	Sex	Mat	Age Str/Smpl#/Age			Vch#	Genetic Str/Smpl#		Roll #	Frame#	Comment
1	EF	1	1	BT	45	.9	U	U									
1	EF	1	1	CRH	40	.8	U	U									
1	EF	1	2	BT	36	.5	U	U									
1	EF	1	2	BT	41	.9	U	U									
1	EF	1	2	CRH	47	.8	U	U									

FDIS Fish Card

Reach #	ILP Map #	ILP #

Watershed Code: 349-524200-00000-00000-0000-0000-000-000-000-000-000-000 1.0

INDIVIDUAL FISH DATA																	
Site#	MTD/NO		H/P	Species	Length	Weight	Sex	Mat	Age			Vch#	Genetic		Roll #	Frame#	Comment
									Str/Smpl#/Age				Str/Smpl#				
1	EF	1	3	BT	45	.9	U	U									
2	EF	1	1	LSU	94	9.7	U	U									
2	EF	1	1	LSU	91	6.1	U	U									
2	EF	1	1	LSU	74	9.4	U	U									
2	EF	1	1	LSU	116	16.3	U	U									
2	EF	1	1	LSU	61	2.3	U	U									
2	EF	1	1	LSU	72	4.1	U	U									
2	EF	1	2	LSU	99	9.6	U	U									
2	EF	1	2	LSU	111	14.6	U	U									
2	EF	1	3	CRH	71	4.3	U	U									
2	EF	1	3	LSU	74	4.6	U	U									
2	EF	1	3	LSU	119	16.9	U	U									
2	EF	1	3	LSU	105	12.3	U	U									
2	EF	1	3	LSU	109	14.7	U	U									
2	EF	1	3	LSU	108	12.5	U	U									
3	EF	1	1	CRH	46	1.1	U	U									
3	EF	1	1	CRH	42	.7	U	U									
3	EF	1	1	CRH	41	.7	U	U									
3	EF	1	1	CRH	65	3.5	U	U									
3	EF	1	1	LSU	80	4.9	U	U									
3	EF	1	1	LSU	78	5.4	U	U									
3	EF	1	1	CRH	50	5.8	U	U									
3	EF	1	2	CRH	49	1.7	U	U									
3	EF	1	2	CRH	48	1.4	U	U									
3	EF	1	2	CRH	50	1.7	U	U									
3	EF	1	2	CRH	52	1.6	U	U									
3	EF	1	2	CRH	42	1.0	U	U									
3	EF	1	3	CRH	53	1.4	U	U									
3	EF	1	3	CRH	49	1.3	U	U									

COMMENTS	
Section	Comments
WATERBODY	"Reach 1" corresponds to section 1 as in MWLAP contract - not a true reach No.
WATERBODY	Site 3 - riffle margin photos: 7 u/s; 8 x/c; 9 d/s;
WATERBODY	Velocity transect located just d/s of site 1;
WATERBODY	Site 2 Glide margin; photos 4 - u/s; 5 x/s; 6 d/s;
WATERBODY	Site 1 - bedrock pool Pictures 1 d/s; 2 x/c; 3 u/s;

FDIS Fish Card

	Reach #	ILP Map #	ILP #
Watershed Code: 349-524200-00000-00000-0000-0000-000-000-000-000-000-000	2.0		

WATERBODY

Gazetted Name: SKOOKUMCHUCK CREEK — Local: FSR KM 38
Project Code: 349-524200-00000-00000-0000-0000-000-000-000-000-000-
WS Code: 349-524200-00000-00000-0000-0000-000-000-000-000-000-000
Waterbody ID: — ILP Map #: — ILP #: — Reach #: 2 -
Project ID: 5862 — Lake/Stream: S — Lake From Date:

Fish Permit #: 02-04-0860 Date: 2002/08/14 To: 2002/08/14 Agency: C214 Crew: SC/KM/JB Resample: ☐

SITE / METHOD

Site#	NID Map	NID #	UTM:Zone/East/North/Mthd				MTD/NO		Temp	Cond	Turbid	Comment
3		6	11	575403	5536341	GP3	EF	1	11.8	38	C	Pool margin
2		5	11	575419	5536080	GP3	EF	1	11.4	39	C	Riffle margin
1		4	11	575264	5536093	GP3	EF	1	10.7	39	C	Glide margin

A. GEAR SETTINGS

Site#	MTD/NO		H/P	Date In	Time In	Date Out	Time Out	Comment
1	EF	1	1	2002/08/14	09:14	2002/08/14	09:38	
1	EF	1	2	2002/08/14	09:43	2002/08/14	10:05	
1	EF	1	3	2002/08/14	10:10	2002/08/14	10:32	
2	EF	1	1	2002/08/14	11:20	2002/08/14	11:50	
2	EF	1	2	2002/08/14	11:55	2002/08/14	12:22	
2	EF	1	3	2002/08/14	12:30	2002/08/14	13:58	
3	EF	1	1	2002/08/14	14:25	2002/08/14	14:46	
3	EF	1	2	2002/08/14	14:50	2002/08/14	15:12	
3	EF	1	3	2002/08/14	15:15	2002/08/14	15:32	

C. ELECTROFISHER SPECIFICATIONS

Site#	MTD/NO		H/P	Encl	Sec	Length	Width	Voltage	Frequency	Pulse	Make	Model
1	EF	1	1	C	919	27.0	6.0	400	60	6	SR	12A
1	EF	1	2	C	897	27.0	6.0	400	60	6	SR	12A
1	EF	1	3	C	815	27.0	6.0	400	60	6	SR	12A
2	EF	1	1	C	1286	32.0	5.7	400	60	6	SR	12A
2	EF	1	2	C	1038	32.0	5.7	400	60	6	SR	12A
2	EF	1	3	C	948	32.0	5.7	400	60	6	SR	12A
3	EF	1	1	C	930	30.0	3.6	400	60	6	SR	12A
3	EF	1	2	C	841	30.0	3.6	400	60	6	SR	12A
3	EF	1	3	C	831	30.0	3.6	400	60	6	SR	12A

FISH SUMMARY

Site#	MTD/NO		H/P	Species	Stage	Age	Total #	Lgth (Min/Max)		FishAct	Comment
1	EF	1	1	BT	F	0+	1	52	52	R	
1	EF	1	2	BT	F	0+	1	44	44	R	
1	EF	1	3	NFC			0				
2	EF	1	1	BT	J	1+	2	89	90	R	
2	EF	1	1	BT	F	0+	17	38	49	R	
2	EF	1	2	BT	F	0+	13	40	49	R	
2	EF	1	2	BT	J	1+	2	79	89	R	
3	EF	1	1	WCT	J	3+	1	211	211	R	
3	EF	1	1	BT	F	0+	1	41	41	R	
3	EF	1	2	BT	F	0+	5	36	44	R	
3	EF	1	3	NFC			0				

INDIVIDUAL FISH DATA

Site#	MTD/NO		H/P	Species	Length	Weight	Sex	Mat	Age Str/Smpl#/Age			Vch#	Genetic Str/Smpl#		Roll #	Frame#	Comment
1	EF	1	1	BT	52	1.2	U	U									
1	EF	1	2	BT	44	.8	U	U									damaged spine
2	EF	1	1	BT	89	7.5	U	U									
2	EF	1	1	BT	48	.9	U	U									
2	EF	1	1	BT	47	1.0	U	U									
2	EF	1	1	BT	43	.7	U	U									
2	EF	1	1	BT	46	.8	U	U									

FDIS Fish Card

Reach # ILP Map # ILP #

Watershed Code: 349-524200-00000-00000-0000-0000-000-000-000-000-000-000 2.0

I N D I V I D U A L F I S H D A T A																	
Site#	MTD/NO		H/P	Species	Length	Weight	Sex	Mat	Age			Vch#	Genetic		Roll #	Frame#	Comment
									Str/Smpl#/Age				Str/Smpl#				
2	EF	1	1	BT	46	1.0	U	U									
2	EF	1	1	BT	47	1.1	U	U									
2	EF	1	1	BT	47	1.0	U	U									
2	EF	1	1	BT	46	.9	U	U									
2	EF	1	1	BT	45	.9	U	U									
2	EF	1	1	BT	48	1.0	U	U									
2	EF	1	1	BT	41	.6	U	U									
2	EF	1	1	BT	42	.7	U	U									
2	EF	1	1	BT	44	.9	U	U									
2	EF	1	1	BT	90	7.2	U	U									
2	EF	1	1	BT	49	1.1	U	U									
2	EF	1	1	BT	46	.9	U	U									
2	EF	1	1	BT	38	.5	U	U									
2	EF	1	1	BT	43	.8	U	U									
2	EF	1	2	BT	45	.8	U	U									
2	EF	1	2	BT	79	5.4	U	U									
2	EF	1	2	BT	49	1.1	U	U									
2	EF	1	2	BT	46	.9	U	U									
2	EF	1	2	BT	43	.8	U	U									
2	EF	1	2	BT	89	7.7	U	U									
2	EF	1	2	BT	44	.8	U	U									
2	EF	1	2	BT	48	1.1	U	U									
2	EF	1	2	BT	46	1.0	U	U									
2	EF	1	2	BT	45	1.0	U	U									
2	EF	1	2	BT	46	.9	U	U									
2	EF	1	2	BT	46	1.0	U	U									
2	EF	1	2	BT	47	1.1	U	U									
2	EF	1	2	BT	40	.6	U	U									
2	EF	1	3	BT	44	1.0	U	U									
3	EF	1	1	BT	41	.8	U	U									
3	EF	1	1	WCT	211	94.1	U	U									
3	EF	1	2	BT	36	.3	U	U									
3	EF	1	2	BT	42	.7	U	U									
3	EF	1	2	BT	44	.8	U	U									
3	EF	1	2	BT	41	.6	U	U									
3	EF	1	2	BT	41	.4	U	U									

C O M M E N T S	
Section	Comments
WATERBODY	"Reach 2" refers to MWLAP Section 2; not neccesarily the true reach 2
WATERBODY	Site 3 Pool margin Pictures: 31 d/s; 32 x/c; 33 u/s;
WATERBODY	Site 2 photos: 27 x/s; 28, 29 u/s; 30 d/s;
WATERBODY	Site 1 Photos: 24 u/s; 25 x/c; 26 d/s;

FDIS Fish Card

		Reach #	ILP Map #	ILP #
Watershed Code:	349-524200-00000-00000-0000-0000-000-000-000-000-000-000	3.0		

WATERBODY

Gazetted Name: SKOOKUMCHUCK CREEK   Local: FSR KM 42.5
Project Code: 349-524200-00000-00000-0000-0000-000-000-000-000-000-
WS Code: 349-524200-00000-00000-0000-0000-000-000-000-000-000-000
Waterbody ID: ILP Map #:   ILP #:   Reach #: 3 -
Project ID: 5862   Lake/Stream: S   Lake From Date:

Fish Permit #: 02-04-0860   Date: 2002/08/16   To: 2002/08/16   Agency: C214   Crew: SC/KM/JB   Resample: ☐

SITE / METHOD

Site#	NID Map	NID #	UTM:Zone/East/North/Mthd				MTD/NO		Temp	Cond	Turbid	Comment
3		9	11	572405	5535125	GP3	EF	1	10.9	48	C	Glide margin
2		8	11	572360	5535334	GP3	EF	1	9.6	37	C	Riffle margin
1		7	11	572245	5535476	GP3	EF	1	8.4	40	C	Pool margin

A. GEAR SETTINGS

Site#	MTD/NO		H/P	Date In	Time In	Date Out	Time Out	Comment
1	EF	1	1	2002/08/16	09:37	2002/08/16	10:06	
1	EF	1	2	2002/08/16	10:08	2002/08/16	10:30	
1	EF	1	3	2002/08/16	10:33	2002/08/16	10:53	
2	EF	1	1	2002/08/16	11:47	2002/08/16	12:20	
2	EF	1	2	2002/08/16	12:23	2002/08/16	12:41	
2	EF	1	3	2002/08/16	12:43	2002/08/16	13:01	
3	EF	1	1	2002/08/16	14:08	2002/08/16	14:30	
3	EF	1	2	2002/08/16	14:32	2002/08/16	14:55	
3	EF	1	3	2002/08/16	15:00	2002/08/16	15:20	

C. ELECTROFISHER SPECIFICATIONS

Site#	MTD/NO		H/P	Encl	Sec	Length	Width	Voltage	Frequency	Pulse	Make	Model
1	EF	1	1	C	1164	30.0	4.5	400	60	6	SR	12A
1	EF	1	2	C	986	30.0	4.5	400	60	6	SR	12A
1	EF	1	3	C	979	30.0	4.5	400	60	6	SR	12A
2	EF	1	1	C	989	29.2	5.4	400	60	6	SR	12A
2	EF	1	2	C	746	29.2	5.4	400	60	6	SR	12A
2	EF	1	3	C	847	29.2	5.4	400	60	6	SR	12A
3	EF	1	1	C	1002	18.5	9.3	400	60	6	SR	12A
3	EF	1	2	C	898	18.5	9.3	400	60	6	SR	12A
3	EF	1	3	C	865	18.5	9.3	400	60	6	SR	12A

FISH SUMMARY

Site#	MTD/NO		H/P	Species	Stage	Age	Total #	Lgth (Min/Max)		FishAct	Comment
1	EF	1	1	BT	F	0+	19	36	48	R	
1	EF	1	2	BT	F	0+	11	40	49	R	
1	EF	1	3	BT	F	0+	2	42	47	R	
2	EF	1	1	BT	F	0+	1	50	50	R	
2	EF	1	2	BT	F	0+	1	48	48	R	
2	EF	1	3	BT	F	0+	2	47	47	R	
3	EF	1	1	WCT	F	1+	1	55	55	R	
3	EF	1	1	BT	F	1+	1	95	95	R	
3	EF	1	2	BT	F	0+	1	45	45	R	
3	EF	1	3	NFC			0				

INDIVIDUAL FISH DATA

Site#	MTD/NO		H/P	Species	Length	Weight	Sex	Mat	Age			Vch#	Genetic		Roll #	Frame#	Comment
									Str/Smpl#/Age				Str/Smpl#				
1	EF	1	1	BT	46	.9	U	U									
1	EF	1	1	BT	38	.5	U	U									
1	EF	1	1	BT	48	1.1	U	U									
1	EF	1	1	BT	44	.7	U	U									
1	EF	1	1	BT	43	.7	U	U									
1	EF	1	1	BT	45	.8	U	U									
1	EF	1	1	BT	44	.7	U	U									
1	EF	1	1	BT	44	.7	U	U									

FDIS Fish Card

Reach # ILP Map # ILP #

Watershed Code: 349-524200-00000-00000-0000-0000-000-000-000-000-000-000 3.0

INDIVIDUAL FISH DATA																	
Site#	MTD/NO		H/P	Species	Length	Weight	Sex	Mat	Age			Vch#	Genetic		Roll #	Frame#	Comment
									Str/Smpl#/Age				Str/Smpl#				
1	EF	1	1	BT	46	.8	U	U									
1	EF	1	1	BT	48	1.0	U	U									
1	EF	1	1	BT	46	1.0	U	U									
1	EF	1	1	BT	45	.9	U	U									
1	EF	1	1	BT	36	.5	U	U									
1	EF	1	1	BT	46	.9	U	U									
1	EF	1	1	BT	48	1.0	U	U									
1	EF	1	1	BT	43	.7	U	U									
1	EF	1	1	BT	45	.8	U	U									
1	EF	1	1	BT	46	.9	U	U									
1	EF	1	1	BT	47	.7	U	U									
1	EF	1	2	BT	42	.6	U	U									
1	EF	1	2	BT	47	.9	U	U									
1	EF	1	2	BT	48	1.0	U	U									
1	EF	1	2	BT	40	.6	U	U									
1	EF	1	2	BT	43	.7	U	U									
1	EF	1	2	BT	44	.9	U	U									
1	EF	1	2	BT	43	.7	U	U									
1	EF	1	2	BT	44	.6	U	U									
1	EF	1	2	BT	49	1.2	U	U									
1	EF	1	2	BT	47	.9	U	U									
1	EF	1	2	BT	42	.7	U	U									
1	EF	1	3	BT	42	.8	U	U									
1	EF	1	3	BT	47	1.1	U	U									
2	EF	1	1	BT	50	1.3	U	U									
2	EF	1	2	BT	48	1.1	U	U									
2	EF	1	3	BT	47	1.1	U	U									
2	EF	1	3	BT	47	1.2	U	U									
3	EF	1	1	BT	95	9.2	U	U									missing part of caudal fin
3	EF	1	1	WCT	55	1.9	U	U									
3	EF	1	2	BT	45	1.1	U	U									

COMMENTS	
Section	Comments
WATERBODY	"Reach 3" corresponds to section 3 in MWLAP contract not neccesarily true reach 3
WATERBODY	Juvenile BT missing part of lower caudal fin;
WATERBODY	Site 3 glide margin; photos:41 u/s; 42 x/s; 43 d/s;
WATERBODY	Site 2 Riffle margin; photos: 38 u/s; 39 x/s; 40 d/s;
WATERBODY	Site 1 - pool margin; pictures 34 u/s; 35, 36 x/c; 37 d/s;

FDIS Fish Sampling

roject Watershed Code:349-524200-00000-00000-0000-0000-000-000-000-000-000-000

Watershed Code: 349-524200-00000-00000-0000-0000-000-000-000-000-000-000 Waterbody ID: ILP Map: ILP: Crew: SC/JB/KM Re-Sample: No

Reach	Site	Capture Method	Method Number	Temp (C)	Cond	Turbid	Haul ID	Date in (ymd) Time in	Len In (Min)	Net Trap Specs			Electrofisher Specs							Species	Total	Length (mm)	
										Type	Length	Depth	Encl	Sec	Length	Width	Voltage	Freq	Pulse			Min	Max
1	1	EF	1	11.3	61	C	1	02/08/12 10:00					C	1072	16	10	300	60	6	CRH	1	40	40
1	1	EF	1	11.3	61	C	1	02/08/12 10:00					C	1072	16	10	300	60	6	BT	1	45	45
1	1	EF	1	11.3	61	C	2	02/08/12 10:30					C	1138	16	10	300	60	6	BT	2	36	41
1	1	EF	1	11.3	61	C	2	02/08/12 10:30					C	1138	16	10	300	60	6	CRH	1	47	47
1	1	EF	1	11.3	61	C	3	02/08/12 11:05					C	1150	16	10	300	60	6	BT	1	45	45
1	2	EF	1	13.2	65	C	1	02/08/12 12:45					C	1075	26.3	7.3	300	60	6	LSU	6	61	116
1	2	EF	1	13.2	65	C	2	02/08/12 13:25					C	813	26.3	7.3	300	60	6	LSU	2	99	111
1	2	EF	1	13.2	65	C	3	02/08/12 13:47					C	726	36.3	7.3	300	60	6	LSU	5	74	119
1	2	EF	1	13.2	65	C	3	02/08/12 13:47					C	726	36.3	7.3	300	60	6	CRH	1	71	71
1	3	EF	1	13.6	79	C	1	02/08/12 15:35					C	1278	25	6	300	60	6	LSU	2	78	80
1	3	EF	1	13.6	79	C	1	02/08/12 15:35					C	1278	25	6	300	60	6	CRH	5	41	50
1	3	EF	1	13.6	79	C	2	02/08/12 16:15					C	885	25	6	300	60	6	CRH	5	42	52
1	3	EF	1	13.6	79	C	3	02/08/12 16:44					C	798	25	6	300	60	6	CRH	2	49	53
2	1	EF	1	10.7	39	C	1	02/08/14 9:14					C	919	27	6	400	60	6	BT	1	52	52
2	1	EF	1	10.7	39	C	2	02/08/14 9:43					C	897	27	6	400	60	6	BT	1	44	44
2	1	EF	1	10.7	39	C	3	02/08/14 10:10					C	815	27	6	400	60	6	NFC	0		
2	2	EF	1	11.4	39	C	1	02/08/14 11:20					C	1286	32	5.7	400	60	6	BT	2	89	90
2	2	EF	1	11.4	39	C	1	02/08/14 11:20					C	1286	32	5.7	400	60	6	BT	17	38	49
2	2	EF	1	11.4	39	C	2	02/08/14 11:55					C	1038	32	5.7	400	60	6	BT	2	79	89
2	2	EF	1	11.4	39	C	2	02/08/14 11:55					C	1038	32	5.7	400	60	6	BT	13	40	49
2	2	EF	1	11.4	39	C	3	02/08/14 12:30					C	948	32	5.7	400	60	6				
2	3	EF	1	11.8	38	C	1	02/08/14 14:25					C	930	30	3.6	400	60	6	BT	1	41	41
2	3	EF	1	11.8	38	C	1	02/08/14 14:25					C	930	30	3.6	400	60	6	WCT	1	211	211
2	3	EF	1	11.8	38	C	2	02/08/14 14:50					C	841	30	3.6	400	60	6	BT	5	36	44
2	3	EF	1	11.8	38	C	3	02/08/14 15:15					C	831	30	3.6	400	60	6	NFC	0		
3	1	EF	1	8.4	40	C	1	02/08/16 9:37					C	1164	30	4.5	400	60	6	BT	19	36	48
3	1	EF	1	8.4	40	C	2	02/08/16 10:08					C	986	30	4.5	400	60	6	BT	11	40	49
3	1	EF	1	8.4	40	C	3	02/08/16 10:33					C	979	30	4.5	400	60	6	BT	2	42	47
3	2	EF	1	9.6	37	C	1	02/08/16 11:47					C	989	29.2	5.4	400	60	6	BT	1	50	50
3	2	EF	1	9.6	37	C	2	02/08/16 12:23					C	746	29.2	5.4	400	60	6	BT	1	48	48
3	2	EF	1	9.6	37	C	3	02/08/16 12:43					C	847	29.2	5.4	400	60	6	BT	2	47	47
3	3	EF	1	10.9	48	C	1	02/08/16 14:08					C	1002	18.5	9.3	400	60	6	BT	1	95	95
3	3	EF	1	10.9	48	C	1	02/08/16 14:08					C	1002	18.5	9.3	400	60	6	WCT	1	55	55
3	3	EF	1	10.9	48	C	2	02/08/16 14:32					C	898	18.5	9.3	400	60	6	BT	1	45	45
3	3	EF	1	10.9	48	C	3	02/08/16 15:00					C	865	18.5	9.3	400	60	6	NFC	0		

Appendix C

FHAP Level 1 Form 4 Data

Level 1 - Habitat Summary Diagnosis Report

Form Num	997
rest District:	
tershed Name:	SKOOKUMCHUCK CREEK
tershed Code:	349-524200-00000-00000-0000-0000-000-000-000-000-000-000
vey Date:	10/1/2002
eather:	CLOUDY/SHOWERS
rvey Crew:	SC/KM
ischarge:	7.52 (CUBIC METERS PER

Subsampling Fractions:

Riffles	Pools	Glides	Cascades	Other
1 in 1	1 in 1	1 in 1	1 in 1	1 in 1

TS Maps (1:50,000)	GS Maps (1:20,000
082G13	082G091
082F16	082G092
	082G081
	082J001
	082F090
	082K010
	082F100

Detail No	Sub Basin Name	Reach No	Section No	UTM Zone	UTM Easting	UTM Northing	Distance (m)	Habitat Unit Type	Habitat Unit Cat	Length (m)	Grad (%)	Mean Depth Bankfull (m)	Mean Depth Water	Mean Width Bankfull (m)	Mean Width Wetted	Pools Only Max Depth	Pools Only Crest	Pools Only Residu	Pools Only Pool
1	OOKUMCHU	1	1				10	R	1	107	0.56	1.2	0.59	36	23.3				
Comments : start at Hydrometric station below bridge																			
2	OOKUMCHU	1	1				70	G	3	37	0.36	1.5	0.71	38	29				
Comments : a few pairs of KO spawning																			
3	OOKUMCHU	1	1				107	R	1	113	0.76	1.7	0.7	26.9	21.3				
Comments :																			
5	OOKUMCHU	1	1				220	P	1	48	0.35	1.8	0.89	31.3	26.9	1	0.4	0.6	S
Comments : steep bank stabilizing																			

Form Num
997

Bed Material Type						Total LWD	Functional LWD			Cover				Offchannel Habitat			Disturbance Indicators			Riparian Vegetation			Barriers
Dom.	Sub-Dom.	D90	Compact	SG Type	SG Amt		10 -	20 - 50c	>50	Cover Type 1	%	Cover Type 2	%	Type	Access	Length (m)	1	2	3	Type	Structure	Canopy	
C	G	330	M	R	L	0				B	5									S	SHR	1	N
C	G	300	M	R	L	0				B	5									S	SHR	1	N
B	C	500	M	R	N	1				B	12						EB			S	SHR	1	N
C	B	350	M	R	N	0				B	10	DP	15							S	SHR	1	N

Level 1 - Habitat Summary Diagnosis Report

6	OOKUMCHU	1	1	11	588414	5524766	268	R	1	282	0.80	1.4	0.43	33.4	29.3				

COMMENTS :

riffle cross-section and EF Site

7	OOKUMCHU	1	1	11	588383	5529899	550	P	1	100	0.1	2.3	1.23	26	17.2	1.6	0.5	1.1	S

COMMENTS :

pool cross-section; EF site; KO spawning in margin (LUB)

8	OOKUMCHU	1	1	11	588451	5530088	650	G	1	17	0.18	1.4	0.74	28.1	23.1				

COMMENTS :

glide ef site; Ko spawning

9	OOKUMCHU	1	1	11	588447	5530138	667	R	1	153	0.86	1.4	0.59	34.4	22.3				

COMMENTS :

Ko spawning; LWD is one big Jam at head riffle creating small off-channel habitat

C	B	350	M	R	N	0				B	10	C	2				EB			S	SHR	1	N
C	R	1E+03	L	R	L	2	2			DP	25	B	10							M	MF	1	N
C	G	250	L	R	L	1				B	2	C	2							M	MF	1	N
C	B	300	M	R	L	45	14	24	3	C	2	B	2	SC	G	40	MB	MC	EB	M	MF	1	N

Level 1 - Habitat Summary Diagnosis Report

Form Num
998

rest District:	
tershed Name:	SKOOKUMCHUCK CREEK
tershed Code:	349-524200-00000-00000-0000-0000-000-000-000-000-000-000

vey Date: 9/28/2002 | eather: SUNNY | rvey Crew: SC/KM

ischarge: 5.73 (cubic meters per

Subsampling Fractions:

Riffles	Pools	Glides	Cascades	Other
1 in 1	1 in 1	1 in 1	1 in 1	1 in 1

TS Maps (1:50,000)
082G13
082F16

GS Maps (1:20,000
082F100
082K010
082F090
082J001
082G091
082G081
082G092

Detail No	Sub Basin Name	Reach No	Section No	UTM Zone	UTM Easting	UTM Northing	Distance (m)	Habitat Unit Type	Habitat Unit Cat	Length (m)	Grad (%)	Mean Depth Bankfull (m)	Mean Depth Water	Mean Width Bankfull (m)	Mean Width Wette	Pools Only Max Depth	Pools Only Crest	Pools Only Residu	Pool
1	OOKUMCHU	2	2	11	575209	5536239	4	R	1	13	0.72	1.2	0.43	35.5	21.2				
Comments :																			
2	OOKUMCHU	2	2				16	P	1	27	0.89	1.7	0.75	29.2	19.8	0.9	0.4	0.5	S
Comments :																			
3	OOKUMCHU	2	2				44	R	1	18	2.76	1.3	0.44	42.5	26.4				
Comments :																			
4	OOKUMCHU	2	2				62	P	1	96	0	1.85	0.89	30.3	17.2	1	0.49	0.51	S
Comments : very minor disturbance factors																			

Form Num
998

Bed Material Type						Tot al LWD	unctional LWD			Cover				Offchannel Habitat			Disturbance Indicators			Riparian Vegetation			Barri ers
Dom.	Sub-Dom.	D90	Com pact	SG Type	SG Amt		10 -	20 - 50c	>50	Cover Type 1	%	Cover Type 2	%	Type	Acces s	Lengt h (m)	1	2	3	Type	Struct ure	Canop y	
C	B	350	L	R	L	0				B	5	IV	2	SC	P	400				C	MF	1	N
G	C	300	L	R	L	2		1		B	2	C	2							C	MF	1	N
C	B	400	L	R	L	0				B	10			SC	P	50				C	MF	1	N
G	C	300	L	R	H	5				B	5	DP	20				EB	DW		C	MF	1	N

Level 1 - Habitat Summary Diagnosis Report

5	DOKUMCHU	2	2				158	R	1	50	0.26	1.6	0.66	35.3	11.9			

Comments :

groundwater upwelling

6	DOKUMCHU	2	2	11	575261	5536154	208	P	1	70	0.01	3	2.03	35.5	33.4	2.71	0.4	2.31	S

Comments :

pool x-sectn

7	DOKUMCHU	2	2	11	575264	5536093	278	R	1	65	0.89	1.3	0.4	33.2	32.3			

Comments :

EF Glide at top riffle - MB is transverse bar forming below pool

8	DOKUMCHU	2	2				343	P	1	52	0.09	2.5	1.4	28.1	17.6	1.65	0.35	1.3	S

Comments :

Lots of instream filementous algae - groundwater input/minerals?

9	DOKUMCHU	2	2	11	572183	5535065	395	R	1	58	0.78	1.2	0.45	40.7	19.3			

Comments :

Riffle x-section and EF site

10	DOKUMCHU	2	2				453	P	1	57	0.03	2.5	1.71	34.8	22.1	2.75	0.58	2.17	S

Comments :

11	DOKUMCHU	2	2				510	R	1	77	0.59	1.1	0.59	32	20.7			

Comments :

sc that entered at start exits here

12	DOKUMCHU	2	2	11	575403	5536341	587	P	1	73	0.01	1.8	1.53	25.4	13.2	1.65	0.4	1.25	S

Comments :

pool EF site

13	DOKUMCHU	2	2				660	G	1	28	0.06	1.7	0.71	28.5	16			

Comments :

BT redds

14	DOKUMCHU	2	2				688	R	1	112	0.71	1.4	0.5	32.8	21.5			

Comments :

C	B	350	L	R	L	1				B	5	IV	2				EB			C	MF	1	N
C	G	300	L	R	L	1				DP	70	B	5							C	MF	1	N
G	C	300	L	R	H	4	3	1		C	5	LWD	5				MB			C	MF	1	N
B	C	400	L	R	N	1	1			DP	30	B	20							C	MF	1	N
B	C	400	L	R	N	2				DP	30	B	20							C	MF	1	N
G	S	200	L	R	L	8	3	4		DP	45	LWD	10							C	MF	1	N
G	B	320	L	R	L	4	2	2		B	5	LWD	2	SC	P	400				C	MF	1	N
G	C	330	L	R	H	5	2	3		DP	40	LWD	2				EB			C	MF	1	N
G	C	330	L	R	H	0				B	10	IV	5							C	MF	1	N
B	G	400	L	R	H	3	3			B	30	IV	5							C	MF	1	N

Level 1 - Habitat Summary Diagnosis Report

15	OOKUMCHU	2	2	11	575704	5536300	800	P	1	90	0.07	1.7	1.12	33	22	1.3	0.48	0.82	S

COMMENTS :

BT REDDS

C	G	330	L	R	H	1	1			B	15	IV	5							C	MF	1	N

Level 1 - Habitat Summary Diagnosis Report

Form Num	
999	
REST DISTRICT:	
TERSHED NAME:	SKOOKUMCHUCK CREEK
TERSHED CODE:	349-524200-00000-00000-0000-0000-000-000-000-000-000-000
VEY DATE:	9/24/2002
EATHER:	SHOWERS
RVEY CREW:	SC/KM
ISCHARGE:	5.05 (CUBIC METERS PER

SUBSAMPLING FRACTIONS:

RIFFLES	POOLS	GLIDES	CASCADES	OTHER
1 IN 1	1 IN 1	1 IN 1	1 IN 1	1 IN 1

TS MAPS (1:50,000)	GS MAPS (1:20,000
082G13	082F100
082F16	082K010
	082F090
	082J001
	082G091
	082G081
	082G092

DETAIL NO	SUB BASIN NAME	REACH NO	SECTION NO	UTM ZONE	UTM EASTING	UTM NORTHING	DISTANCE (M)	HABITAT UNIT TYPE	HABITAT UNIT CAT	LENGTH (M)	GRAD (%)	MEAN DEPTH BANKFULL (M)	MEAN DEPTH WATER	MEAN WIDTH BANKFULL (M)	MEAN WIDTH WETTE	POOLS ONLY MAX DEPTH	POOLS ONLY CREST	POOLS ONLY RESIDU	POOL
1	OOKUMCHU	3	3	11	572178	5535070	0	R	1	50	0.65	1.2	0.51	33	16.1				

COMMENTS :

RIFFLE X-SECTION

DETAIL NO	SUB BASIN NAME	REACH NO	SECTION NO	UTM ZONE	UTM EASTING	UTM NORTHING	DISTANCE (M)	HABITAT UNIT TYPE	HABITAT UNIT CAT	LENGTH (M)	GRAD (%)	MEAN DEPTH BANKFULL (M)	MEAN DEPTH WATER	MEAN WIDTH BANKFULL (M)	MEAN WIDTH WETTE	POOLS ONLY MAX DEPTH	POOLS ONLY CREST	POOLS ONLY RESIDU	POOL
2	OOKUMCHU	3	3	11	572183	5535065	50	G	1	45	0.36	1.05	0.45	35.8	20.3				

COMMENTS :

DETAIL NO	SUB BASIN NAME	REACH NO	SECTION NO	UTM ZONE	UTM EASTING	UTM NORTHING	DISTANCE (M)	HABITAT UNIT TYPE	HABITAT UNIT CAT	LENGTH (M)	GRAD (%)	MEAN DEPTH BANKFULL (M)	MEAN DEPTH WATER	MEAN WIDTH BANKFULL (M)	MEAN WIDTH WETTE	POOLS ONLY MAX DEPTH	POOLS ONLY CREST	POOLS ONLY RESIDU	POOL
3	OOKUMCHU	3	3				95	R	1	12	1.23	0.95	0.42	40.3	21.7				

COMMENTS :

DETAIL NO	SUB BASIN NAME	REACH NO	SECTION NO	UTM ZONE	UTM EASTING	UTM NORTHING	DISTANCE (M)	HABITAT UNIT TYPE	HABITAT UNIT CAT	LENGTH (M)	GRAD (%)	MEAN DEPTH BANKFULL (M)	MEAN DEPTH WATER	MEAN WIDTH BANKFULL (M)	MEAN WIDTH WETTE	POOLS ONLY MAX DEPTH	POOLS ONLY CREST	POOLS ONLY RESIDU	POOL
4	OOKUMCHU	3	3				107	P	1	63	0.20	1.2	0.82	40	21	0.95	0.31	0.64	S

COMMENTS :

START BRAID AND SPAWNING BT/REDDS

Form Num
999

Bed Material Type						Tot al LWD	Functional LWD			Cover				Offchannel Habitat			Disturbance Indicators			Riparian Vegetation			Barriers
Dom.	Sub-Dom.	D90	Compact	SG Type	SG Amt		10 -	20 - 50c	>50	Cover Type 1	%	Cover Type 2	%	Type	Access	Length (m)	1	2	3	Type	Structure	Canopy	
C	B	350	L	R	N	3	2	1		B	5									C	MF	1	N
C	G	300	L	R	N	2	1			B	2	C	2							C	MF	1	N
C	G	300	L	R	L	0				B	2	C	2				DW	MB		C	MF	1	N
C	G	290	L	R	L	2	2			C	5	B	10				DW	MB	MC	C	MF	1	N

Level 1 - Habitat Summary Diagnosis Report

5	OOKUMCHU	3	3				170	R	1	10	1.43	1.3	0.68	38	27				

Comments :

C=RUN

6	OOKUMCHU	3	3				170	G	3	30	0.2	1.3	0.41	38	27				

Comments :

BT SPAWNING BRAID. NO COVER BUT EXCELLENT SUBSTRATE - 8 REDDS

7	OOKUMCHU	3	3				180	R	1	50	0.72	1.08	0.54	38	31.25				

Comments :

REDDS AND HOLDING BT IN LWD

8	OOKUMCHU	3	3				230	P	1	70	0.05	1.6	1.2	26.6	16.1	1.4	0.32	1.08	S

Comments :

9	OOKUMCHU	3	3	11	572405	5535125	300	G	1	25	0.12	1.1	0.56	26.6	25.7				

Comments :

BT REDDS; EF SITE

10	OOKUMCHU	3	3	11	572360	5535334	325	R	1	75	0.72	1.2	0.47	41.8	15.3				

Comments :

EF SITE

11	OOKUMCHU	3	3				400	G	1	36	0.24	1	0.6	28.2	20.1				

Comments :

12	OOKUMCHU	3	3				436	R	1	34	0.35	1.3	0.57	30	16.5				

Comments :

13	OOKUMCHU	3	3				470	P	1	30	0.16	1.2	0.87	34.5	17.3	1	0.3	0.7	S

Comments :

14	OOKUMCHU	3	3				500	G	1	39	0.06	1.1	0.52	36	19.5				

Comments :

REDDS IN FRONT OF TRANSVERS BAR

C	G	300	L	R	L					C	2	SWD	2				DW	MB	MC	C	MF	1	N
G	C	220	L	R	H					C	2						DW	MB	MC	C	MF	1	N
G	C	250	L	R	H	8	7	1		LWD	10	C	5				MB	MC	DW	C	MF	1	N
B	C	400	L	R	L	3	1	1		DP	60	B	15				EB			C	MF	1	N
G	C	250	L	R	H	0				B	5	IV	5							C	MF	1	N
C	B	350	L	R	N	8	5			B	2			SC	P	75	MB			C	MF	1	N
G	C	300	L	R	L					B	2	OV	5	SC	P	36	MB			C	MF	1	N
C	G	300	L	R	L	2	1	1		B	2	OV	5				DW			C	MF	1	N
C	G	300	L	R	L	1			1	OV	5	IV	5							C	MF	1	N
G	C	250	L	R	H	3	1			OV	5	C	2							C	MF	1	N

Level 1 - Habitat Summary Diagnosis Report

15	DOKUMCHU	3	3				539	R	1	91	0.81	1.22	0.55	32.2	15	0.75	0.4	0.35	S

COMMENTS :

REDDS

17	DOKUMCHU	3	3	11	572245	5535476	630	P	1	80	0.11	1.7	0.89	25.3	14.3	1.05	0.5	0.55	S

COMMENTS :

POOL X-SECTN; EF SITE; BT HOLDING POOL

18	DOKUMCHU	3	3				710	G	1	30	0.20	1.3	0.61	27.4	14.8				

COMMENTS :

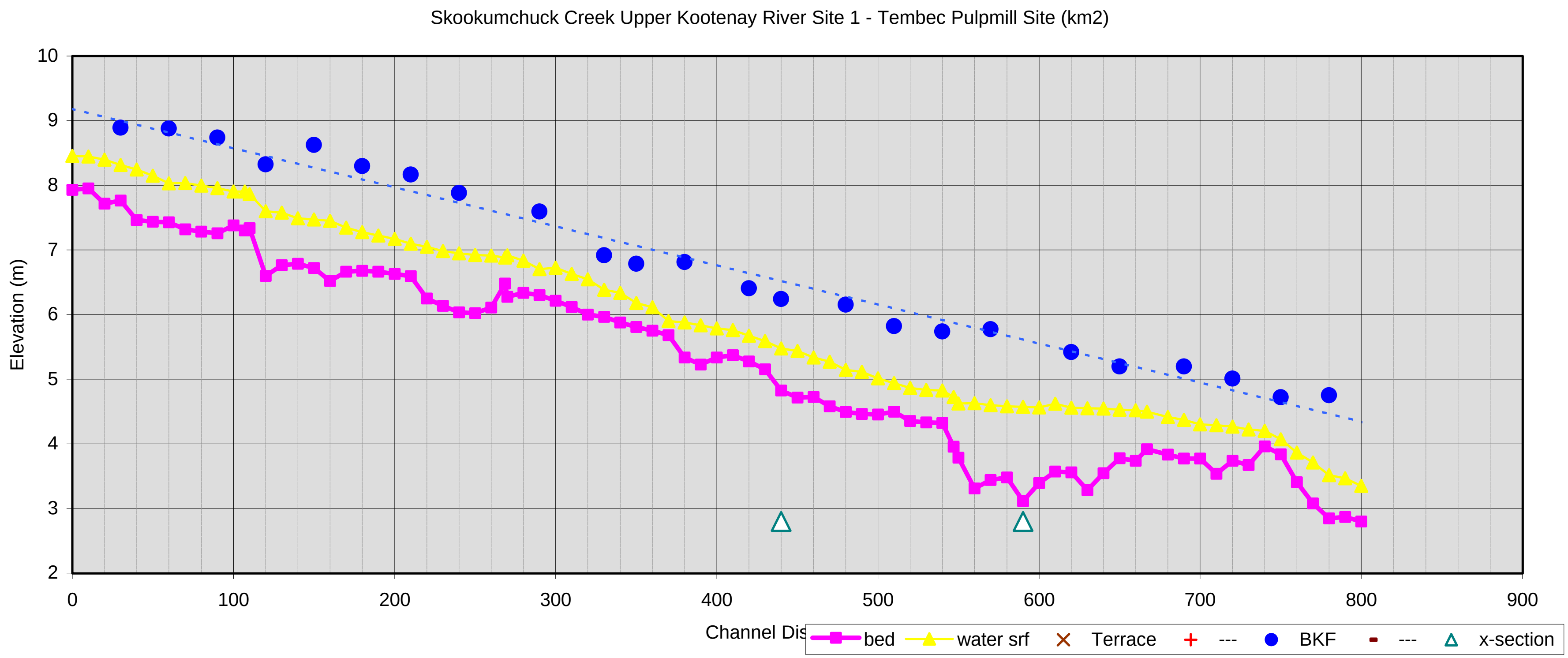
19	DOKUMCHU	3	3	11	572358	5535685	740	P	1	60	0.02	1.6	0.86	29.2	15.1	0.95	0.41	0.54	S

COMMENTS :

G	C	250	L	R	H	11	7	4		LWD	10	C	5							C	MF	1	N
C	S	200	L	R	L	4		1		DP	30	OV	10							C	MF	1	N
C	G	300	L	R	L	0				B	10	OV	5							C	MF	1	N
G	C	250	L	R	H	6	3	1		B	15	OV	10							C	MF	1	N

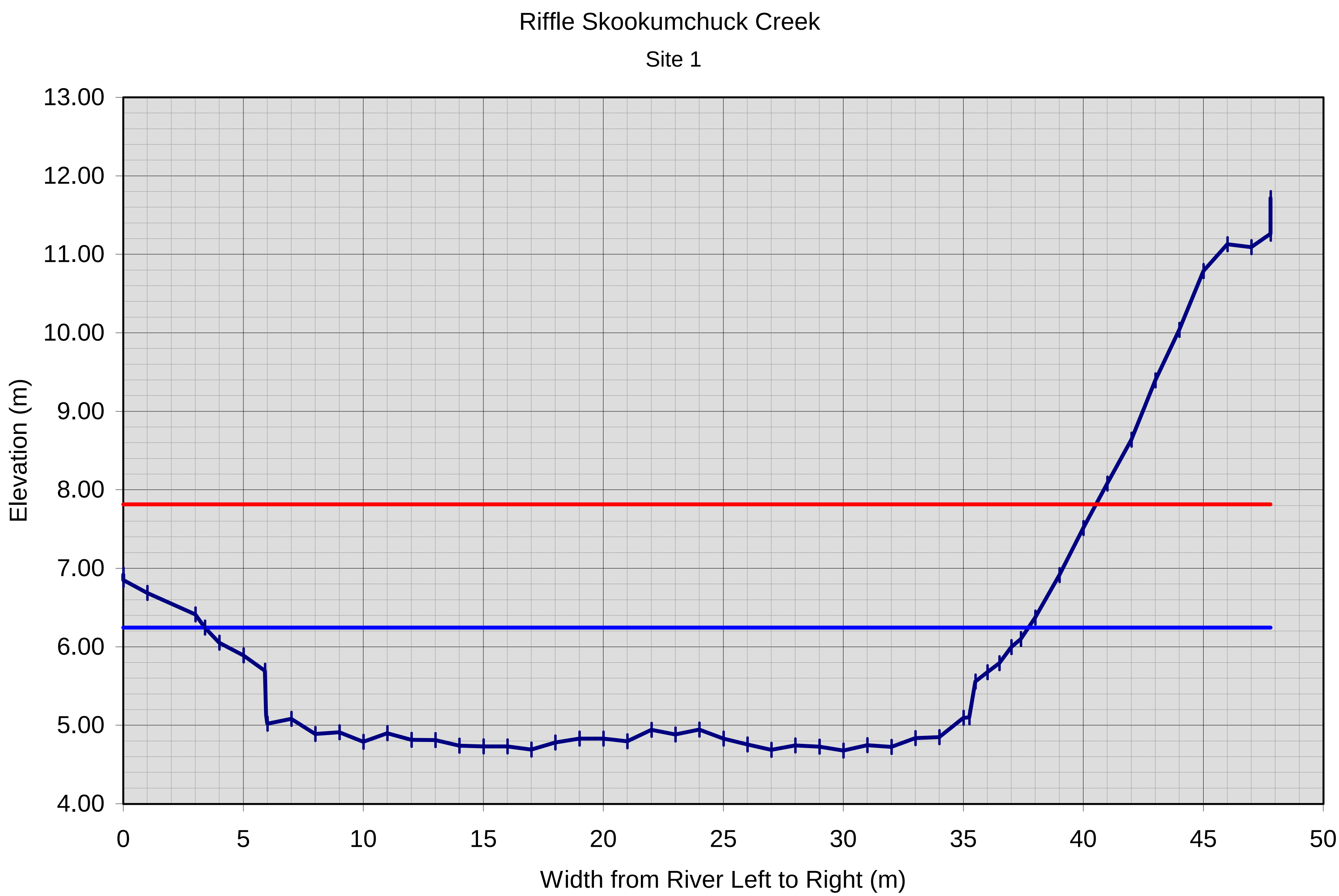
Appendix D

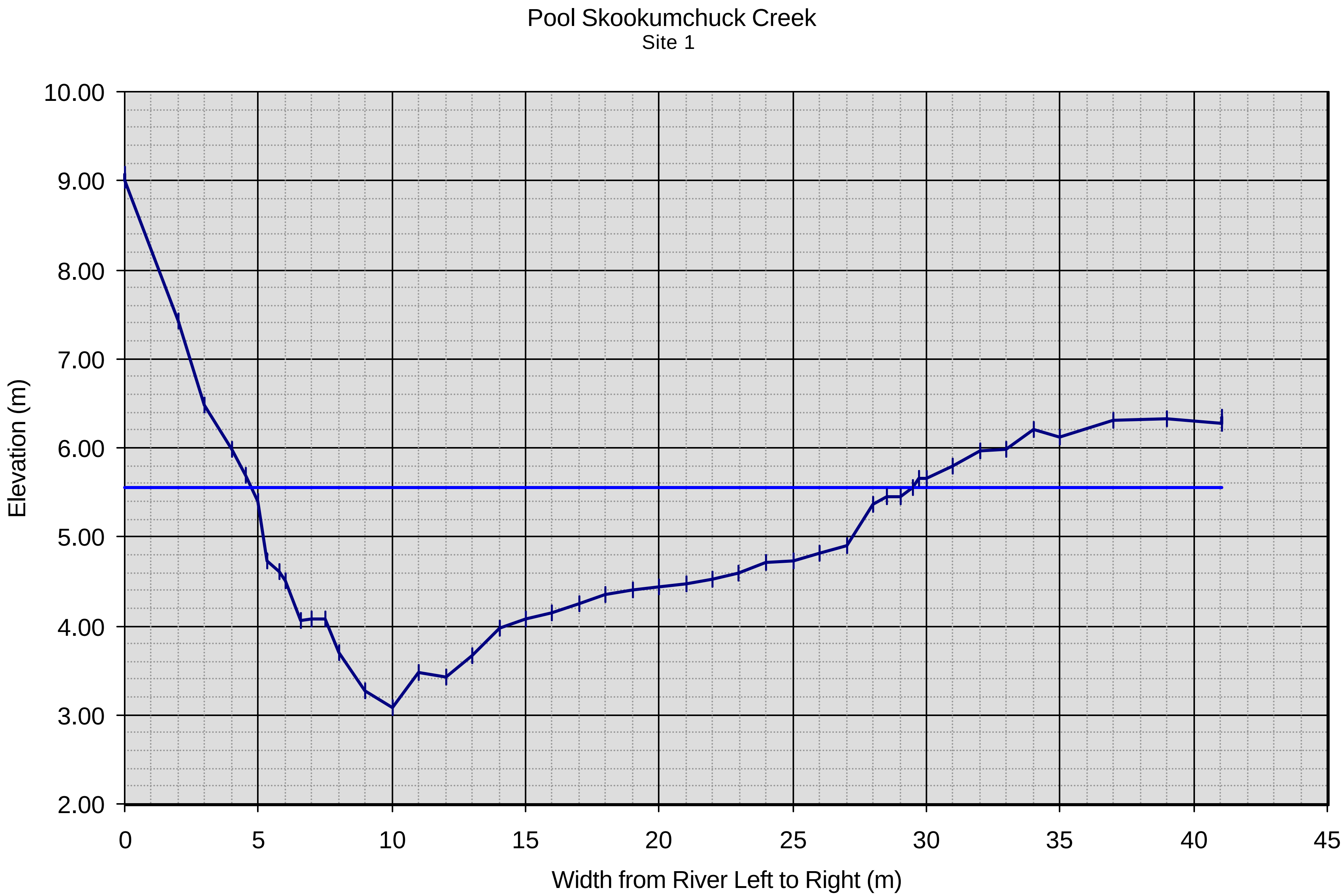
FHAP Channel Survey Data

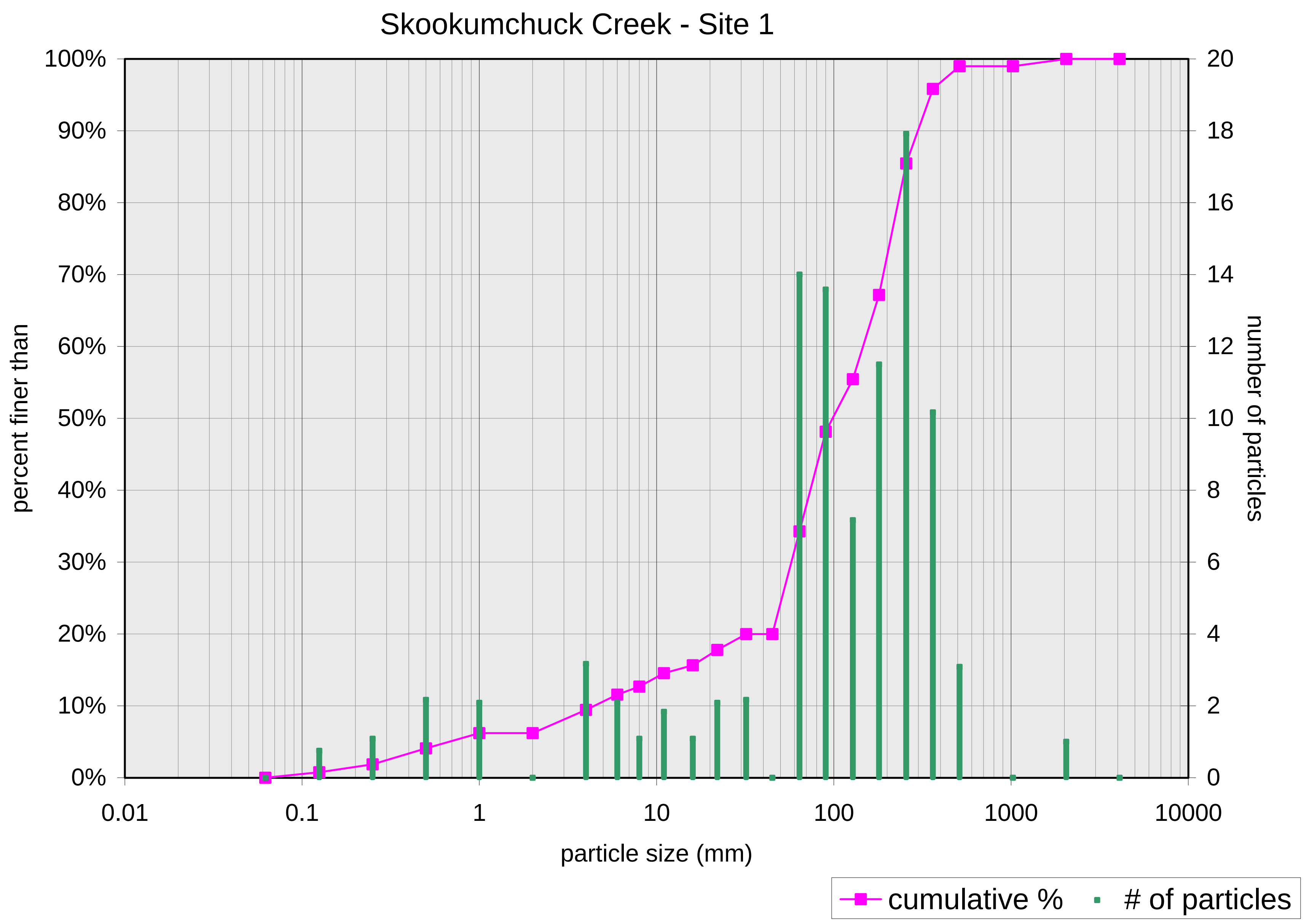


Skookumchuck Creek Upper Kootenay River Site 1 - Tembec Pulpmill Site (km2)
Elevation (m)
10
9
8
7
6
5
4
3
2
0
100
200
300
400
500
600
700
800
900
Channel Dis
bed
water srf
Terrace

BKF
---
x-section


Riffle Skookumchuck Creek
Site 1
Elevation (m)
13.00
12.00
11.00
10.00
9.00
8.00
7.00
6.00
5.00
4.00
0
5
10
15
20
25
30
35
40
45
50
Width from River Left to Right (m)


Pool Skookumchuck Creek
Site 1
Elevation (m)
10.00
9.00
8.00
7.00
6.00
5.00
4.00
3.00
2.00
0
5
10
15
20
25
30
35
40
45
Width from River Left to Right (m)


Skookumchuck Creek - Site 1
percent finer than
number of particles
particle size (mm)
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
20
18
16
14
12
10
8
6
4
2
0
0.01
0.1
1
10
100
1000
10000
cumulative %
# of particles

Skookumchuck Creek
Site 1 - Tembec Pulpmill Site (km2)
29-Sep-02
Scott Cope and Kerry Morris

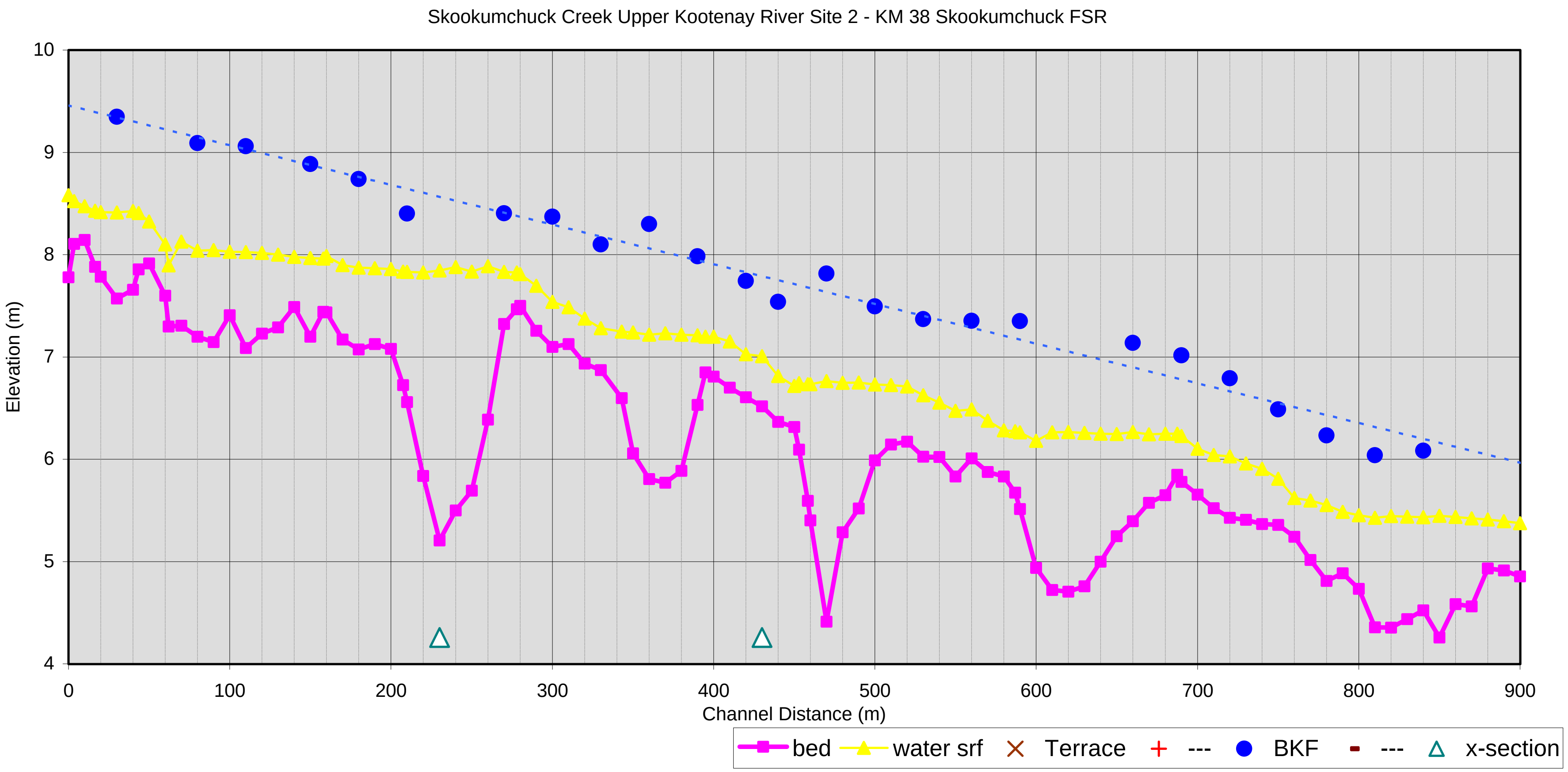
Field (Arbitrary) Elevations (m)

Station	Backsight	Height of Instrument	Foresight	Elevation	Comment
BM1	0.94	10.940		10.000	Lag Bolt Base Tree Rub
RP1	0.887	8.849	2.978	7.962	
RP2	0.686	7.804	1.731	7.118	
RP3	0.524	6.996	1.332	6.472	
RP4	1.123	6.068	2.051	4.945	
RP5	1.162	5.901	1.329	4.739	
BM4			0.857	5.044	Lag Bolt Base Tree Rub
BM4	0.857	5.901		5.044	
RP5	1.328	6.068	1.161	4.740	
RP4	1.954	6.899	1.123	4.945	
RP3	1.37	7.842	0.428	6.471	
RP2	1.57	8.687	0.724	7.118	
RP1	3.05	11.015	0.726	7.961	
BM1			1.014	10.001	

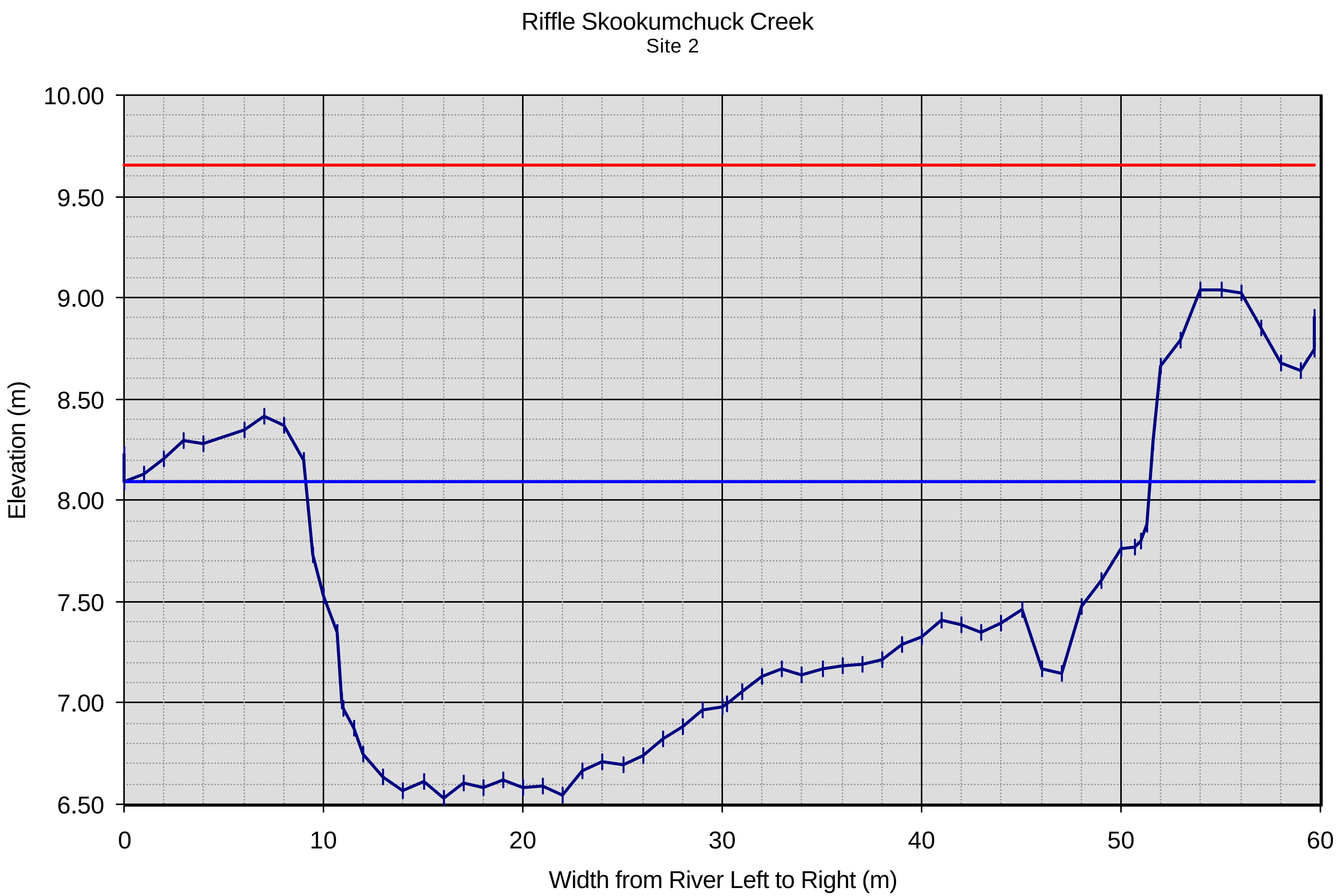
ERROR = 0.001

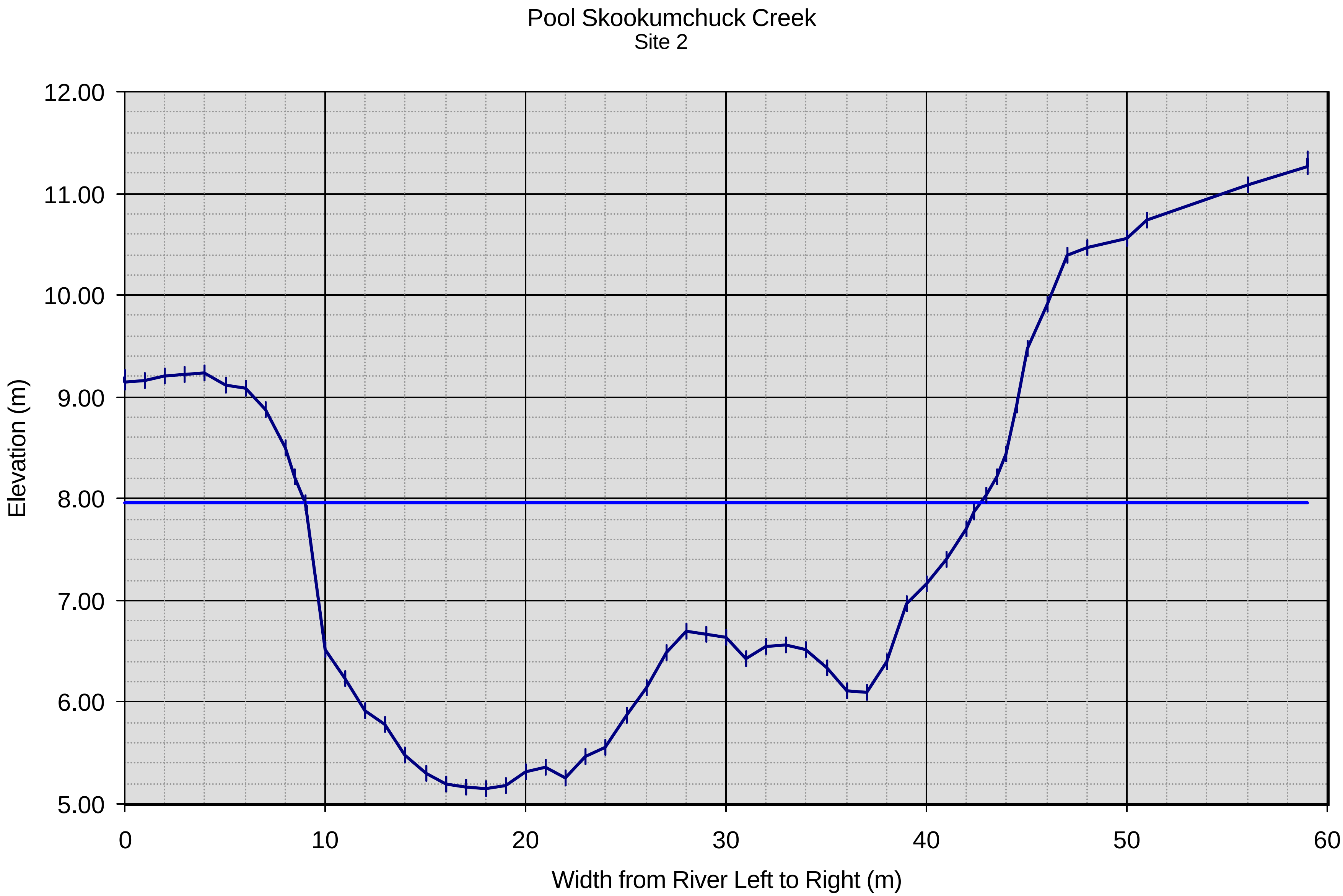
NOTE

Elevation = 7.574 m
BM3 = Rbar Pin base of LUB tree at pool cross-section 0+ 594.5
Elevation =

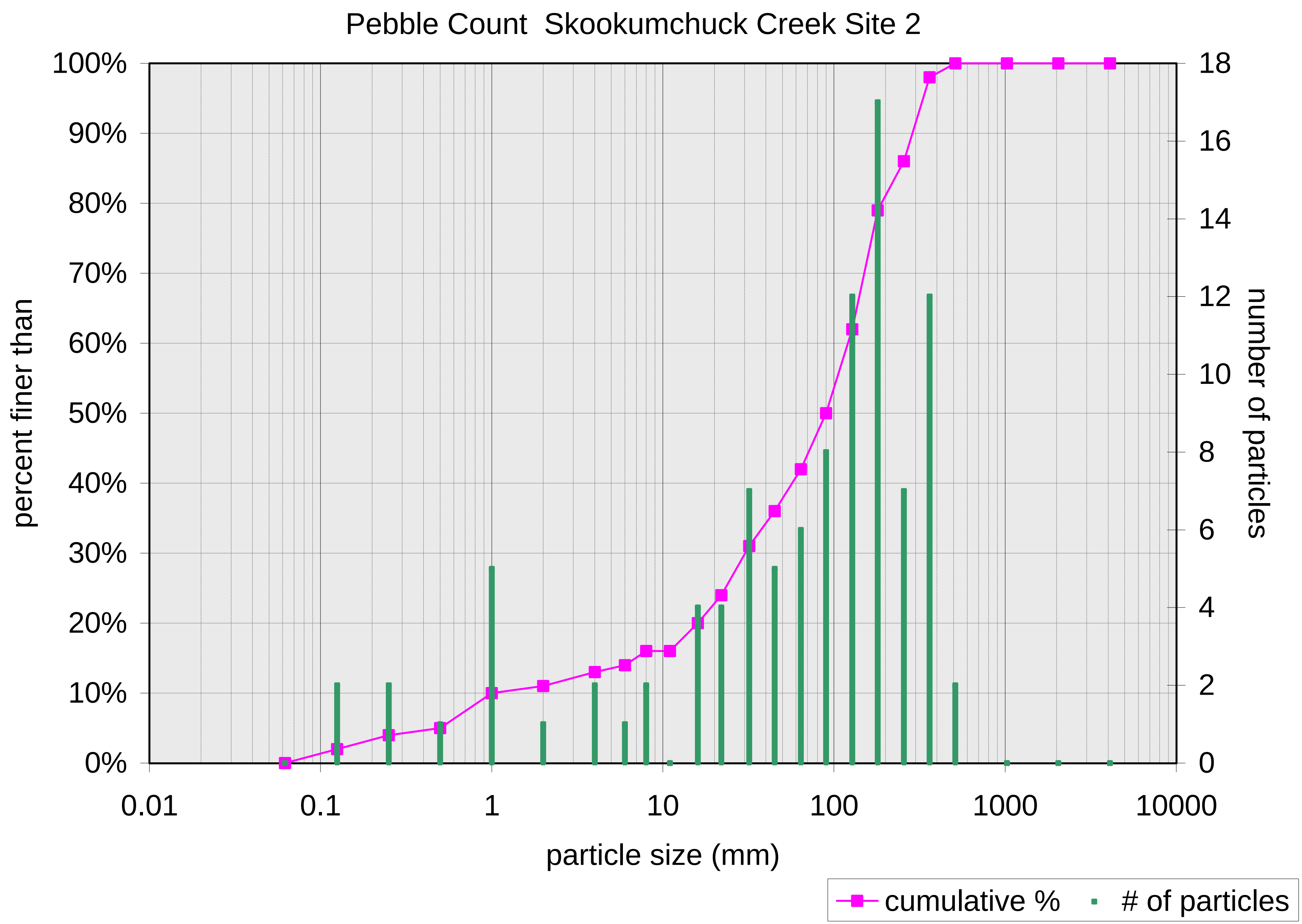

Skookumchuck Creek Upper Kootenay River Site 2 - KM 38 Skookumchuck FSR
Elevation (m)
10
9
8
7
6
5
4
0
100
200
300
400
500
600
700
800
900
Channel Distance (m)
bed
water srf
Terrace

BKF
---
x-section


Riffle Skookumchuck Creek
Site 2
Elevation (m)
10.00
9.50
9.00
8.50
8.00
7.50
7.00
6.50
0
10
20
30
40
50
60
Width from River Left to Right (m)



Pool Skookumchuck Creek
Site 2
Elevation (m)
12.00
11.00
10.00
9.00
8.00
7.00
6.00
5.00
0
10
20
30
40
50
60
Width from River Left to Right (m)

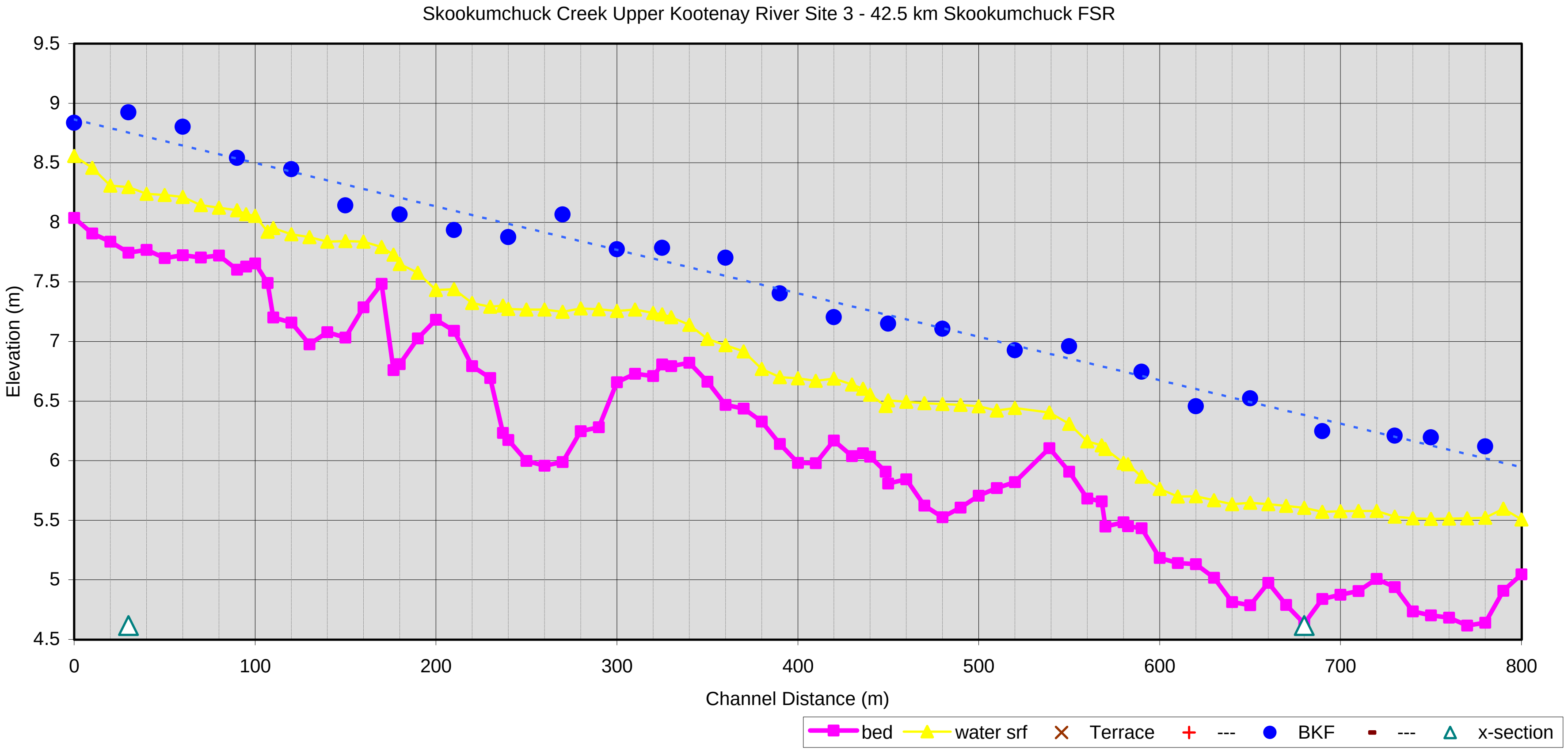


Pebble Count Skookumchuck Creek Site 2
percent finer than
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
0.01
0.1
1
10
100
1000
10000
particle size (mm)
18
16
14
12
10
8
6
4
2
0
number of particles
cumulative %
# of particles

Skookumchuck Creek
Site 2 - KM 38 Skookumchuck FSR
26-Sep-02
Scott Cope and Kerry Morris

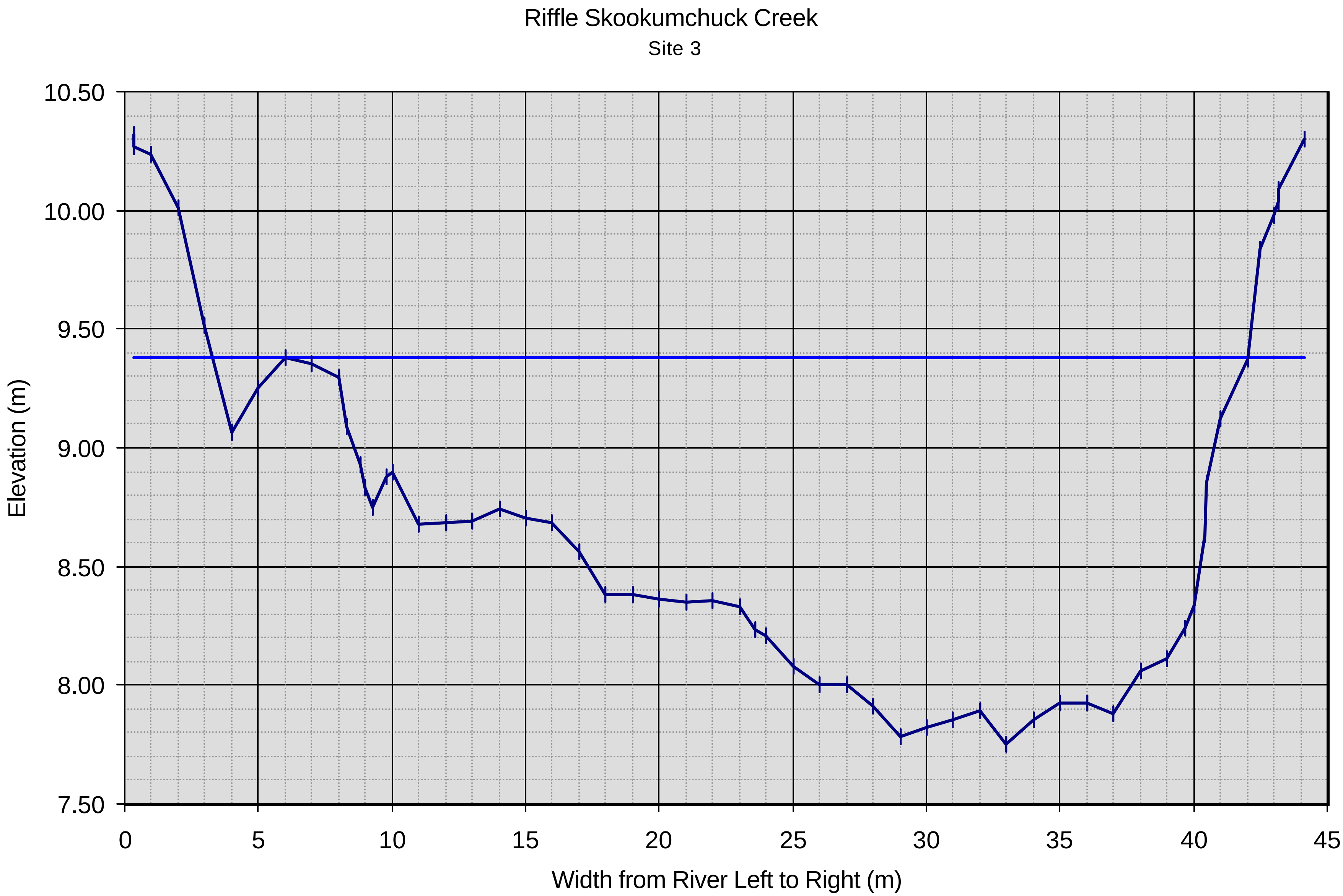
Field (Arbitrary) Elevations (m)

Station	Backsight	Height of Instrument	Foresight	Elevation	Comment
BM1	1.148	11.148		10.000	Tree Lag bolt behind start tagged tree(RUB-0+ 1m)
RP1	1.869	10.345	2.672	8.476	
RP2	1.207	9.681	1.871	8.474	
BM2			0.131	9.550	pool x-sectn benchmark-not in loop (RUB-0+237)
RP3	1.548	9.173	2.056	7.625	
RP4	1.614	8.453	2.334	6.839	
BM3			1.248	7.205	riffle x-sectn benchmark-not in loop(LUB 0+428)
RP5	1.536	7.926	2.063	6.390	
RP6	0.955	7.232	1.649	6.277	
BM4			0.344	6.888	Tree lag bolt on RUB at 0+827.6m
BM4			0.344	6.888	
RP6	1.645	7.922	0.955	6.277	
RP5	2.071	8.462	1.531	6.391	
RP4	2.429	9.267	1.624	6.838	
RP3	2.044	9.668	1.643	7.624	
RP2	1.865	10.337	1.196	8.472	
RP1	2.626	11.101	1.862	8.475	
BM1			1.102	9.999	
			error=	-0.001	

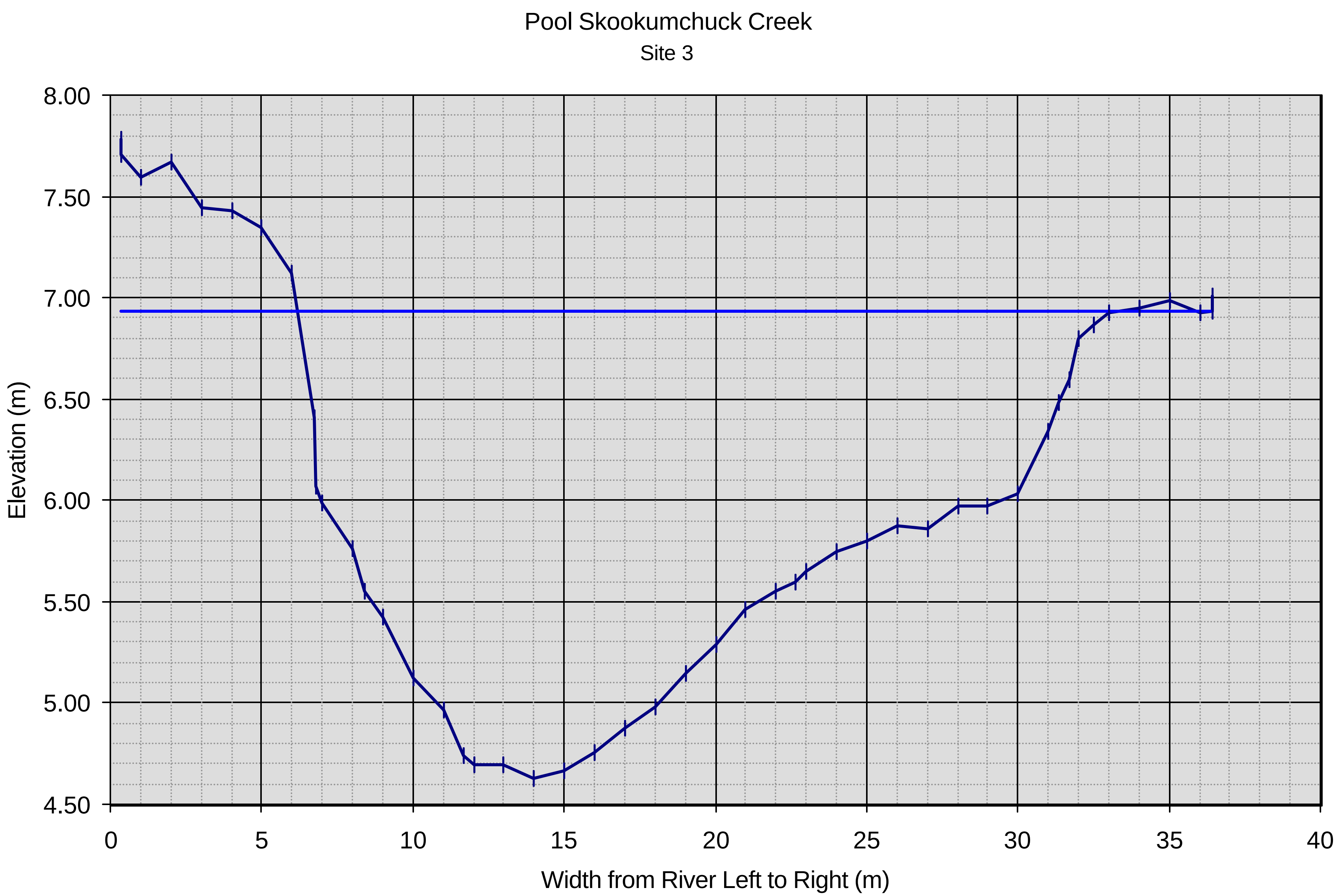


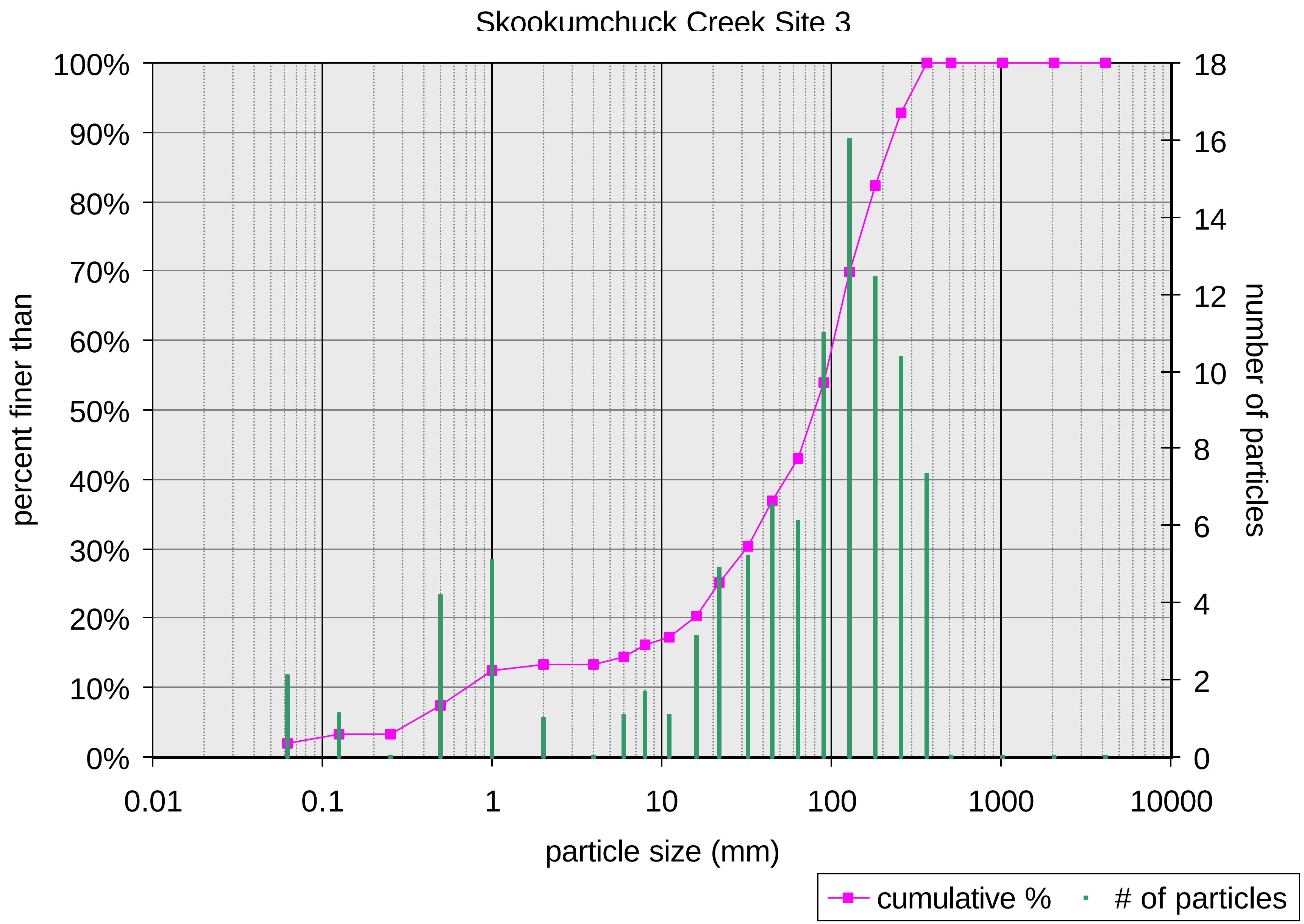
Skookumchuck Creek Upper Kootenay River Site 3 - 42.5 km Skookumchuck FSR
Elevation (m)
9.5
9
8.5
8
7.5
7
6.5
6
5.5
5
4.5
0
100
200
300
400
500
600
700
800
Channel Distance (m)
bed
water srf
Terrace

BKF
---
x-section



Riffle Skookumchuck Creek
Site 3
Elevation (m)
10.50
10.00
9.50
9.00
8.50
8.00
7.50
0
5
10
15
20
25
30
35
40
45
Width from River Left to Right (m)


Pool Skookumchuck Creek
Site 3
Elevation (m)
8.00
7.50
7.00
6.50
6.00
5.50
5.00
4.50
0
5
10
15
20
25
30
35
40
Width from River Left to Right (m)



Skookumchuck Creek Site 3
percent finer than
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
number of particles
18
16
14
12
10
8
6
4
2
0
0.01
0.1
1
10
100
1000
10000
particle size (mm)
cumulative %
# of particles

Skookumchuck Creek
Site 3 - 42.5 km Skookumchuck FSR
23-Sep-02
Scott Cope and Kerry Morris

Field (Arbitrary) Elevations (m)

Station	Backsight	Height of Instrument	Foresight	Elevation	Comment
BM1	0.433	10.433		10.000	Lagbolt in base of spruce on LUBat 0m
BM2			0.039	10.394	Lagbolt in treebase LUBat 0+32.7m
RP1	1.029	9.394	2.068	8.365	
RP2	1.306	8.900	1.8	7.594	
RP3	1.095	8.356	1.639	7.261	
RP4	1.021	7.643	1.734	6.622	
RP5	1.544	7.369	1.818	5.825	
BM3			0.399	6.970	Lagbolt in base of spruce on RUBat 0+750m
BM3	0.399	7.369		6.970	
RP5	1.784	7.609	1.544	5.825	
RP4	1.66	8.278	0.988	6.621	
RP3	1.678	8.938	1.018	7.260	
RP2	1.741	9.335	1.344	7.594	
RP1	2.068	10.434	0.969	8.366	
BM2			0.039	10.395	
BM1			0.434	10.000	
			error =	0.000	

BM2 - riffle cross-section survey pin - not in longprofile loop

Appendix E

Stream Channel Classification (Levell) Form

Stream Channel Classification (Level II) Form

Stream Name:	Skookumchuck Creek	Watershed Name:	Kootenay River
Drainage Area (u/s of site)	641 Km^2		
Location:	Site 1 - Pulpmill Site		
Cross-Section Monuments (UTM - Zone.Easting.Northing)		11.588463.5529778	(riffle)
		11.588383.5529899	(pool)
Crew/Company:	SC/KM - Westslope Fisheries Ltd.	Date:	September 29 2002

Bankfull WIDTH (W_{bkf}) WIDTH of the stream channel at bankful stage elevation, in riffle section.	34.30	m
Bankfull DEPTH (d_{bkf}) Mean DEPTH of the stream channel x-section, at bankfull stage elevation, in a riffle section (d_{bkf} = A/W_{bkf}).	1.27	m
Bankfull X-Sectional AREA (A_{bkf}) AREA of the stream channel x-section, at bankfull stage elevation, in riffle section.	43.60	m^2
Width/Depth Ratio (W_{bkf}/d_{bkf}) Bankfull WIDTH divided by bankfull mean DEPTH, in riffle section.	26.98	
Maximum DEPTH (d_{mbkf}) Maximum depth of the bankfull channel x-section, or distance between the bankfull stage and thalweg elevations, in a riffle section.	1.57	m
WIDTH of Flood-Prone Area (W_{fpa}) Twice maximum DEPTH, or (2 x d_{mbkf}) = the stage/elevation at which flood-prone area WIDTH is determined, in a riffle section	164	m
Entrenchment Ratio (ER) The ratio of flood-prone area divided by bankfull channel WIDTH, in a riffle section (W_{fpa}/W_{bkf})	4.79	
Channel Materials (Particle Size Index) D_{50} The D50 particle size index represents the mean diameter of channel materials (n=100), as sampled from the channel surface, between the left and right bankfull stage elevations.	99	mm
Water Surface SLOPE (S) Channel SLOPE = "rise over run" for a reach approximately 20-30 bankfull channel widths in length, with the "top of riffle to riffle" water surface slope representing the gradient at bankfull stage.	0.0065	m/m
Channel SINUOSITY (K) Sinuosity is an index of channel pattern, determined from a ratio of stream length divided by valley length (SL/VL); or estimated from the ratio of valley slope divided by channel slope (VS/S).	1.26	
Stream Type Refer to Page 5-6, Figure 5-3 in Rosgen's 1996, "Applied River Morphology" book.	**C3(1)**	

Stream Channel Classification (Level II) Form

Stream Name:	Skookumchuck Creek	Watershed Name:	Kootenay River
Drainage Area (u/s of site)	442 Km^2		
Location:	Site 2 - km 38 Skookumchuck FSR		
Cross-Section Monuments (UTM - Zone.Easting.Northing)		11.575409.5536231	(riffle)
		11.575261.5536154	(pool)
Crew/Company:	SC/KM - Westslope Fisheries Ltd.	Date:	September 26 2002

Bankfull WIDTH (W_{bkf}) WIDTH of the stream channel at bankful stage elevation, in riffle section.	42.30	m
Bankfull DEPTH (d_{bkf}) Mean DEPTH of the stream channel x-section, at bankfull stage elevation, in a riffle section ($d_{bkf} = A/W_{bkf}$).	1.00	m
Bankfull X-Sectional AREA (A_{bkf}) AREA of the stream channel x-section, at bankfull stage elevation, in riffle section.	44.30	m^2
Width/Depth Ratio (W_{bkf}/d_{bkf}) Bankfull WIDTH divided by bankfull mean DEPTH, in riffle section.	42.30	
Maximum DEPTH (d_{mbkf}) Maximum depth of the bankfull channel x-section, or distance between the bankfull stage and thalweg elevations, in a riffle section.	1.60	m
WIDTH of Flood-Prone Area (W_{fpa}) Twice maximum DEPTH, or (2 x d_{mbkf}) = the stage/elevation at which flood-prone area WIDTH is determined, in a riffle section	116	m
Entrenchment Ratio (ER) The ratio of flood-prone area divided by bankfull channel WIDTH, in a riffle section (W_{fpa}/W_{bkf})	2.74	
Channel Materials (Particle Size Index) D_{50} The D50 particle size index represents the mean diameter of channel materials (n=100), as sampled from the channel surface, between the left and right bankfull stage elevations.	90	mm
Water Surface SLOPE (S) Channel SLOPE = "rise over run" for a reach approximately 20-30 bankfull channel widths in length, with the "top of riffle to riffle" water surface slope representing the gradient at bankfull stage.	0.0035	m/m
Channel SINUOSITY (K) Sinuosity is an index of channel pattern, determined from a ratio of stream length divided by valley length (SL/VL); or estimated from the ratio of valley slope divided by channel slope (VS/S).	1.69	
Stream Type Refer to Page 5-6, Figure 5-3 in Rosgen's 1996, "Applied River Morphology" book.	**C3**	

Stream Channel Classification (Level II) Form

Stream Name:	Skookumchuck Creek	Watershed Name:	Kootenay River
Drainage Area (u/s of site)	419 Km^2		
Location:	Site 3 - km 42.5 Skookumchuck FSR		
Cross-Section Monuments (UTM - Zone.Easting.Northing)		11.572183.5535065	(riffle)
		11.572249.5535612	(pool)
Crew/Company:	SC/KM - Westslope Fisheries Ltd.	Date:	September 23 2002

Bankfull WIDTH (W_{bkf}) WIDTH of the stream channel at bankful stage elevation, in riffle section.	38.70	m
Bankfull DEPTH (d_{bkf}) Mean DEPTH of the stream channel x-section, at bankfull stage elevation, in a riffle section ($d_{bkf} = A/W_{bkf}$).	1.00	m
Bankfull X-Sectional AREA (A_{bkf}) AREA of the stream channel x-section, at bankfull stage elevation, in riffle section.	36.90	m^2
Width/Depth Ratio (W_{bkf}/d_{bkf}) Bankfull WIDTH divided by bankfull mean DEPTH, in riffle section.	38.70	
Maximum DEPTH (d_{mbkf}) Maximum depth of the bankfull channel x-section, or distance between the bankfull stage and thalweg elevations, in a riffle section.	1.60	m
WIDTH of Flood-Prone Area (W_{fpa}) Twice maximum DEPTH, or (2 x d_{mbkf}) = the stage/elevation at which flood-prone area WIDTH is determined, in a riffle section	67	m
Entrenchment Ratio (ER) The ratio of flood-prone area divided by bankfull channel WIDTH, in a riffle section (W_{fpa}/W_{bkf})	1.73	
Channel Materials (Particle Size Index) D_{50} The D50 particle size index represents the mean diameter of channel materials (n=100), as sampled from the channel surface, between the left and right bankfull stage elevations.	80	mm
Water Surface SLOPE (S) Channel SLOPE = "rise over run" for a reach approximately 20-30 bankfull channel widths in length, with the "top of riffle to riffle" water surface slope representing the gradient at bankfull stage.	0.0038	m/m
Channel SINUOSITY (K) Sinuosity is an index of channel pattern, determined from a ratio of stream length divided by valley length (SL/VL); or estimated from the ratio of valley slope divided by channel slope (VS/S).	1.59	
Stream Type Refer to Page 5-6, Figure 5-3 in Rosgen's 1996, "Applied River Morphology" book.	**B3c**	

Appendix F

Reference Reach Data Summary Form

Reference Reach Data Summary Form

Stream Name:	Skookumchuck Creek
Location:	Site 1 - pulpmill site at Skookumchuck

Channel DIMENSION
Data from Riffle & Pool x-sectional surveys

Parameter	Value	Unit	Parameter	Value	Unit
Bankfull Pool Width (W_{bkfp})	29.00	m	Bankfull Riffle Width (W_{bkf})	34.30	m
Bankfull Pool Depth (d_{bkfp})	1.43	m	Bankfull Riffle Depth (d_{bkf})	1.27	m
X-Section Data					
Bankfull Pool XS Area (A_{bkfp})	41.40	m^2	Bankfull Riffle XS Area (A_{bkf})	43.60	m^2
Max. Bankfull Pool Depth (d_{mbkfp})	2.33	m	Max. Bankfull Riffle Depth (d_{mbkf})	1.60	m

X-Section Data

Parameter	(Min.)	Unit	(Max.)	Unit	(Mean)	Unit
Max. Bankfull Pool Depth (d_{mbkfp}) (Long. Profile Data)	1.84	m	2.33	m	2.09	m
Ratio: Bankfull Pool Width/Bankfull Riffle Width:					0.85	$(W_{bkfp})/(W_{bkf})$
Ratio: Bankfull Pool Depth/Bankfull Riffle Depth:					1.12	$(d_{bkfp})/(d_{bkf})$
Ratio: Bankfull Pool XS Area/Bankfull Riffle XS Area:					0.95	$(A_{bkfp})/(A_{bkf})$
Ratio: Bankfull Max. Pool Depth/Bankfull Riffle Depth:	1.45		1.84		1.64	$(d_{mbkfp})/(d_{bkf})$
Ratio: Lowest Bank Height/Max. Bankfull Riffle Depth:	2.16	m			1.35	$Bh_{low}/(d_{mbkf})$

(Lowest Bank Height - measured from thalweg to top of lowest bank, in a riffle section)

Parameter	Value	Unit
Streamflow: Estimated Mean Velocity (u_{bkf}) @ Bankfull Stage (riffle section)	1.91	m/s
Streamflow: Estimated Discharge (Q_{bkf}) @ Bankfull Stage (riffle section)	83.3	m^3/s

Channel PATTERN

Parameter	(Min.)	Unit	(Max.)	Unit	(Mean)	Unit
Meander Length (L_m)	270	m	450	m	349	m
Radius of Curvature (R_c)	90	m	175	m	123	m
Belt Width (W_{BLT})	150	m	240	m	215	m
Ratio: Meander Length/Bankfull Riffle Width	7.87		13.12		10.17	(L_m/W_{bkf})
Ratio: Radius of Curvature/Bankfull Riffle Width	2.62		5.10		3.59	(R_c/W_{bkf})
Meander Width Ratio (MWR):	4.37		7.00		6.27	(W_{BLT}/W_{bkf})

Channel PROFILE
Data from Longitudinal Profile Survey

Parameter	Value	Unit	Parameter	Value	Unit
Valley Slope (VS)	0.0080	m/m	Water Surface SLOPE (S)	0.0065	m/m

Parameter	(Min.)	Unit	(Max.)	Unit	(Mean)	Unit
Riffle Surface Slope (S_r)	0.0076	m/m	0.0086	m/m	0.0081	m/m
Pool Surface Slope (S_p)	0.0010	m/m	0.0035	m/m	0.0022	m/m
Glide Surface Slope (S_g)	0.0018	m/m	0.0033	m/m	0.0025	m/m
Run Surface Slope (S_{run})	0.0061	m/m	0.0199	m/m	0.0130	m/m
Bankfull Max. Riffle Depth (d_{rmax})	1.13		1.37	m	1.26	m
Bankfull Glide Depth (d_g)	1.42	m	1.47	m	1.44	m
Bankfull Run Depth (d_{run})	1.42	m	1.57	m	1.49	m
Pool Length (P_{length})	48.50	m	100.00	m	74.25	m
Pool to Pool Spacing ($P_{spacing}$)	330.00	m	330.00	m	330.00	m
Ratio: Riffle Surface Slope/Water Surface Slope	1.18		1.33		1.25	(S_r/S)
Ratio: Pool Surface Slope/Water Surface Slope	0.15		0.54		0.34	(S_p/S)
Ratio: Glide Surface Slope/Water Surface Slope	0.28		0.51		0.39	(S_g/S)
Ratio: Run Surface Slope/Water Surface Slope	0.94		3.09		2.01	(S_{run}/S)
Ratio: Bankfull Max. Rifffle Depth/Bankfull Riffle Depth	0.89		1.08		0.99	d_{rmax}/d_{bkf}
Ratio: Bankfull Glide Depth/Bankfull Riffle Depth	1.12		1.15		1.13	d_g/d_{bkf}
Ratio: Bankfull Run Depth/Bankfull Riffle Depth	1.11		1.24		1.18	d_g/d_{bkf}
Ratio: Pool Length/Bankfull Riffle Width	1.41		2.92		2.16	P_{length}/W_{bkf}
Ratio: Pool to Pool Spacing/Bankfull Riffle Width	9.62		9.62		9.62	$P_{spacing}/W_{bkf}$

Channel MATERIALS

Material	%	Particle size	(riffle)	(cumulative)	Unit
% Sand & <	6	D_{16}		17	mm
% Gravel	28	D_{35}		65	mm
% Cobble	50	D_{50}		99	mm
% Boulder	14	D_{84}	221	249	mm
% Bedrock	2	D_{95}		352	mm

Reference Reach Data Summary Form

Stream Name: Skookumchuck Creek

Location: Site 2 - km 38 Skookumchuck FSR

Channel DIMENSION

Data from Riffle & Pool x-sectional surveys

Bankfull Pool Width (W_{bkfp})	33.70	m	Bankfull Riffle Width (W_{bkf})	42.30	m
Bankfull Pool Depth (d_{bkfp})	1.80	m	Bankfull Riffle Depth (d_{bkf})	1.05	m
X-Section Data: Bankfull Pool XS Area (A_{bkfp})	60.80	m^2	Bankfull Riffle XS Area (A_{bkf})	44.30	m^2
Max. Bankfull Pool Depth (d_{mbkfp})	3.10	m	Max. Bankfull Riffle Depth (d_{mbkf})	1.60	m

	(Min.)		(Max.)		(Mean)	
X-Section Data: Max. Bankfull Pool Depth (d_{mbkfp}) Long. Profile Data	1.77	m	3.40	m	2.56	m

	(Min.)	(Max.)	Mean	
Ratio: Bankfull Pool Width/Bankfull Riffle Width:			0.80	$(W_{bkfp})/(W_{bkf})$
Ratio: Bankfull Pool Depth/Bankfull Riffle Depth:			1.72	$(d_{bkfp})/(d_{bkf})$
Ratio: Bankfull Pool XS Area/Bankfull Riffle XS Area			1.37	$(A_{bkfp})/(A_{bkf})$
Ratio: Bankfull Max. Pool Depth/Bankfull Riffle Depth:	1.69	3.25	2.45	$(d_{mbkfp})/(d_{bkf})$
Ratio: Lowest Bank Height/Max. Bankfull Riffle Depth:	1.84	m	1.15	$Bh_{low}/(d_{mbkf})$

(Lowest Bank Height - measured from thalwag to top of lowest bank, in a riffle section)

Streamflow: Estimated Mean Velocity (u_{bkf}) @ Bankfull Stage (riffle section)	1.16	m/s
Streamflow: Estimated Discharge (Q_{bkf}) @ Bankfull Stage (riffle section)	51.4	m^3/s

Channel PATTERN

	(Min.)		(Max.)		(Mean)	
Meander Length (L_m)	90	m	230	m	155	m
Radius of Curvature (R_c)	34	m	75	m	53	m
Belt Width (W_{BLT})	60	m	150	m	105	m

	(Min.)	(Max.)	(Mean)	
Ratio: Meander Length/Bankfull Riffle Width	2.13	5.44	3.65	(L_m/W_{bkf})
Ratio: Radius of Curvature/Bankfull Riffle Width	0.79	1.77	1.25	(R_c/W_{bkf})
Meander Width Ratio (MWR):	1.42	3.55	2.48	(W_{BLT}/W_{bkf})

Channel PROFILE

Data from Longitundinal Profile Survey

Valley Slope (VS)	0.0059	m/m	Water Surface SLOPE (S)	0.0035	m/m

	(Min.)		(Max.)		(Mean)	
Riffle Surface Slope (S_r)	0.0072	m/m	0.0109	m/m	0.0092	m/m
Pool Surface Slope (S_p)	0.0001	m/m	0.0015	m/m	0.0006	m/m
Glide Surface Slope (S_g)	0.0008	m/m	0.0026	m/m	0.0015	m/m
Run Surface Slope (S_{run})	0.0019	m/m	0.0055	m/m	0.0035	m/m
Bankfull Max. Riffle Depth (d_{rmax})	1.14		1.51	m	1.32	m
Bankfull Glide Depth (d_g)	1.07	m	1.69	m	1.27	m
Bankfull Run Depth (d_{run})	1.23	m	1.66	m	1.48	m
Pool Length (P_{length})	47.00	m	80.00	m	62.42	m
Pool to Pool Spacing ($P_{spacing}$)	110.00	m	210.00	m	147.60	m

	(Min.)	(Max.)	(Mean)	
Ratio: Riffle Surface Slope/Water Surface Slope	2.05	3.11	2.64	(S_r/S)
Ratio: Pool Surface Slope/Water Surface Slope	0.01	0.43	0.16	(S_p/S)
Ratio: Glide Surface Slope/Water Surface Slope	0.23	0.74	0.43	(S_g/S)
Ratio: Run Surface Slope/Water Surface Slope	0.54	1.57	1.01	(S_{run}/S)
Ratio: Bankfull Max. Rifffle Depth/Bankfull Riffle Depth	1.09	1.44	1.26	d_{rmax}/d_{bkf}
Ratio: Bankfull Glide Depth/Bankfull Riffle Depth	1.02	1.61	1.21	d_g/d_{bkf}
Ratio: Bankfull Run Depth/Bankfull Riffle Depth	1.17	1.59	1.41	d_g/d_{bkf}
Ratio: Pool Length/Bankfull Riffle Width	1.11	1.89	1.48	P_{length}/W_{bkf}
Ratio: Pool to Pool Spacing/Bankfull Riffle Width	2.60	4.96	3.49	$P_{spacing}/W_{bkf}$

Channel MATERIALS

% Sand & <	11	D_{16}		11	mm
% Gravel	31	D_{35}		42	mm
% Cobble	44	D_{50}		90	mm
% Boulder	14	D_{84}	253 (riffle)	231 (cummulative)	mm
% Bedrock		D_{95}		332	mm

Reference Reach Data Summary Form

Stream Name: Skookumchuck Creek

Location: Site 3 - km 42.5 Skookumchuck FSR

Channel DIMENSION

Data from Riffle & Pool x-sectional surveys

Bankfull Pool Width (W_{bkfp})	27.80	m	Bankfull Riffle Width (W_{bkf})		38.70	m
Bankfull Pool Depth (d_{bkfp})	1.38	m	Bankfull Riffle Depth (d_{bkf})		0.95	m
X-Section Data						
Bankfull Pool XS Area (A_{bkfp})	38.30	m^2	Bankfull Riffle XS Area (A_{bkf})		36.90	m^2
Max. Bankfull Pool Depth (d_{mbkfp})	2.10	m	Max. Bankfull Riffle Depth (d_{mbkf})		1.60	m
X-Section Data						
Max. Bankfull Pool Depth (d_{mbkfp}) Long. Profile Data	1.42 m (Min.)		2.08 m (Max.)		1.69 m (Mean)	
Ratio: Bankfull Pool Width/Bankfull Riffle Width:					0.72	$(W_{bkfp})/(W_{bkf})$
Ratio: Bankfull Pool Depth/Bankfull Riffle Depth:					1.44	$(d_{bkfp})/(d_{bkf})$
Ratio: Bankfull Pool XS Area/Bankfull Riffle XS Area:					1.04	$(A_{bkfp})/(A_{bkf})$
Ratio: Bankfull Max. Pool Depth/Bankfull Riffle Depth:			1.49 (Min.)	2.18 (Max.)	1.77 (Mean)	$(d_{mbkfp})/(d_{bkf})$
Ratio: Lowest Bank Height/Max. Bankfull Riffle Depth: (Lowest Bank Height - measured from thalwag to top of lowest bank, in a riffle section)			1.34	m	0.84	$Bh_{low}/(d_{mbkf})$
Streamflow: Estimated Mean Velocity (u_{bkf}) @ Bankfull Stage (riffle section)					1.11	m/s
Streamflow: Estimated Discharge (Q_{bkf}) @ Bankfull Stage (riffle section)					41.0	m^3/s

Channel PATTERN

	(Min.)		(Max.)		(Mean)	
Meander Length (L_m)	310	m	500	m	390	m
Radius of Curvature (R_c)	74	m	210	m	148	m
Belt Width (W_{BLT})	187	m	520	m	329	m
Ratio: Meander Length/Bankfull Riffle Width	8.01		12.92		10.08	(L_m/W_{bkf})
Ratio: Radius of Curvature/Bankfull Riffle Width	1.91		5.43		3.82	(R_c/W_{bkf})
Meander Width Ratio (MWR):	4.83		13.44		8.50	(W_{BLT}/W_{bkf})

Channel PROFILE

Data from Longitudinal Profile Survey

Valley Slope (VS)	0.0059	m/m	Water Surface SLOPE (S)		0.0038	m/m
	(Min.)		(Max.)		(Mean)	
Riffle Surface Slope (S_r)	0.0050	m/m	0.0105	m/m	0.0076	m/m
Pool Surface Slope (S_p)	0.0004	m/m	0.0016	m/m	0.0010	m/m
Glide Surface Slope (S_g)	0.0006	m/m	0.0044	m/m	0.0019	m/m
Run Surface Slope (S_{run})	0.0020	m/m	0.0084	m/m	0.0042	m/m
Bankfull Max. Riffle Depth (d_{rmax})	1.04		1.18	m	1.10	m
Bankfull Glide Depth (d_g)	0.83	m	1.19	m	1.06	m
Bankfull Run Depth (d_{run})	1.26	m	1.34	m	1.30	m
Pool Length (P_{length})	50.00	m	150.00	m	80.75	m
Pool to Pool Spacing ($P_{spacing}$)	123.00	m	230.00	m	174.33	m
Ratio: Riffle Surface Slope/Water Surface Slope	1.32		2.75		2.00	(S_r/S)
Ratio: Pool Surface Slope/Water Surface Slope	0.11		0.41		0.26	(S_p/S)
Ratio: Glide Surface Slope/Water Surface Slope	0.14		1.15		0.49	(S_g/S)
Ratio: Run Surface Slope/Water Surface Slope	0.53		2.19		1.09	(S_{run}/S)
Ratio: Bankfull Max. Rifffle Depth/Bankfull Riffle Depth	1.09		1.24		1.15	d_{rmax}/d_{bkf}
Ratio: Bankfull Glide Depth/Bankfull Riffle Depth	0.87		1.25		1.11	d_g/d_{bkf}
Ratio: Bankfull Run Depth/Bankfull Riffle Depth	1.32		1.41		1.36	d_g/d_{bkf}
Ratio: Pool Length/Bankfull Riffle Width	1.29		3.88		2.09	P_{length}/W_{bkf}
Ratio: Pool to Pool Spacing/Bankfull Riffle Width	3.18		5.94		4.50	$P_{spacing}/W_{bkf}$

Channel MATERIALS

% Sand & <	13	D_{16}		8	mm
% Gravel	30	D_{35}		41	mm
% Cobble	50	D_{50}		80	mm
% Boulder	7	D_{84}	252 (riffle)	190 (cummulative)	mm
% Bedrock		D_{95}		286	mm

Appendix G

Velocity Calculations

Velocity Calculations

Date	September 29 2002	**Gage Number**	
Stream	Skookumchuck Creek Site 1 (pulpmill site)		

Input Variables / Output Variables

Input Variables			Output Variables		
Bankfull Cross Sectional Area (A_{BKF})	43.60	m^2	Bankfull Mean Depth D_{BKF} = (A_{BKF}/W_{BKF})	1.27	m
Bankfull Width (W_{BKF})	34.3	m	Wetted Perimeter (WP) (~(2*D_{BKF})+W_{BKF})	36.8	m
D84 (Riffle)	221	mm	D84 (mm/1000)	0.22	m
Bankfull Slope (S)	0.00645	m/m	Hydraulic Radius (R) (A_{BKF}/WP)	1.18	m
Gravitational Acceleration (g)	9.8	m/s^2	R/D84 (use D84 in meters)	5.35	m/m

R/D84, u/u*, Mannings n

u/u* (using R/D84: see Reference Reach Field Book: p188, River Field Book:p233)	7.0	m/s/ m/s
Mannings n: (Reference Reach Field Book: p189, River Field Book:p236)	0.036	
Velocity: from Manning's equation: $u=R^{2/3}S^{1/2}/n$	2.50	m/s

Resistance as a function of Relative Roughness (Leopold 1994)
u/u*=2.83+5.7logR/D84

u*: $u^*=(gRS)^{0.5}$	0.27	m/s
Velocity: u=u*(2.83+5.7logR/D84)	1.91	m/s

Mannings n by Stream Type

Stream Type		
Mannings n: (Reference Reach Field Book: p187, River Field Book:p237)	0.045	m1/6
Velocity: from Manning's equation $u=R^{2/3}S^{1/2}/n$	2.00	m/s

Continuity Equation

Q_{BKF} (cfs) from slope area estimate at riffle cross section	79.0	cms
Velocity (u=Q/A)	1.81	m/s

Limerinos Equation (1970)

Manning's "n" using: "n" = ($R^{1/6}$ x 0.0926)/(1.16 + 2log(R/D_{84}))	0.0364

Velocity Calculations

Date	September 26 2002		**Gage Number**		
Stream	Skookumchuck Creek Site 2 -FSR Km 38				

Input Variables			**Output Variables**		
Bankfull Cross Sectional Area (A_{BKF})	44.29	m^2	Bankfull Mean Depth D_{BKF} $= (A_{BKF}/W_{BKF})$	1.05	m
Bankfull Width (W_{BKF})	42.3	m	Wetted Perimeter (WP) $(\sim(2*D_{BKF})+W_{BKF})$	44.4	m
D84 (Riffle)	253	mm	D84 (mm/1000)	0.25	m
Bankfull Slope (S)	0.00353	m/m	Hydraulic Radius (R) (A_{BKF}/WP)	1.00	m
Gravitational Acceleration (g)	9.8	m/s^2	R/D84 (use D84 in meters)	3.94	m/m

R/D84, u/u*, Mannings n

u/u* (using R/D84: see Reference Reach Field Book: p188, River Field Book:p233)	5.6	m/s/ m/s
Mannings n: (Reference Reach Field Book: p189, River Field Book:p236)	0.042	
Velocity: from Manning's equation: $u=R^{2/3}S^{1/2}/n$	1.41	m/s

Resistance as a function of Relative Roughness (Leopold 1994)
u/u*=2.83+5.7logR/D84

u*: $u^*=(gRS)^{0.5}$	0.19	m/s
Velocity: u=u*(2.83+5.7logR/D84)	1.16	m/s

Mannings n by Stream Type

Stream Type		
Mannings n: (Reference Reach Field Book: p187, River Field Book:p237)	0.045	m1/6
Velocity: from Manning's equation $u=R^{2/3}S^{1/2}/n$	1.32	m/s

Continuity Equation

Q_{BKF} (cfs) from slope area estimate at riffle cross section	41.11	cms
Velocity (u=Q/A)	0.93	m/s

Limerinos Equation (1970)

Manning's "n" using: "n" = $(R^{1/6} \times 0.0926)/(1.16 + 2\log(R/D_{84}))$	0.0394

Velocity Calculations

Date	September 23 2002	**Gage Number**	
Stream	Skookumchuck Creek Site 3 - FSR Km 42.5		

Input Variables			**Output Variables**		
Bankfull Cross Sectional Area (A_{BKF})	36.90	m^2	Bankfull Mean Depth D_{BKF} = (A_{BKF}/W_{BKF})	0.95	m
Bankfull Width (W_{BKF})	38.7	m	Wetted Perimeter (WP) (~($2*D_{BKF}$)+W_{BKF})	40.6	m
D84 (Riffle)	252	mm	D84 (mm/1000)	0.25	m
Bankfull Slope (S)	0.00382	m/m	Hydraulic Radius (R) (A_{BKF}/WP)	0.91	m
Gravitational Acceleration (g)	9.8	m/s^2	R/D84 (use D84 in meters)	3.61	m/m

R/D84, u/u*, Mannings n

u/u* (using R/D84: see Reference Reach Field Book: p188, River Field Book:p233)	5.7	m/s/ m/s
Mannings n: (Reference Reach Field Book: p189, River Field Book:p236)	0.041	
Velocity: from Manning's equation: $u=R^{2/3}S^{1/2}/n$	1.41	m/s

Resistance as a function of Relative Roughness (Leopold 1994)
u/u*=2.83+5.7logR/D84

u*: $u^*=(gRS)^{0.5}$	0.18	m/s
Velocity: u=u*(2.83+5.7logR/D84)	1.11	m/s

Mannings n by Stream Type

Stream Type		
Mannings n: (Reference Reach Field Book: p187, River Field Book:p237)	0.04	m1/6
Velocity: from Manning's equation $u=R^{2/3}S^{1/2}/n$	1.45	m/s

Continuity Equation

Q_{BKF} (cfs) from slope area estimate at riffle cross section	17.47	cms
Velocity (u=Q/A)	0.47	m/s

Limerinos Equation (1970)

Manning's "n" using: "n" = $(R^{1/6} \times 0.0926)/(1.16 + 2\log(R/D_{84}))$	0.0401